POWER

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Wages and the Cost of Living

IT IS not the amount of money that one receives, but what he can buy with it — the purchasing power of the day's work — that determines the sufficiency or insufficiency of wages.

The Philadelphia Rapid Transit Company proposes to pay its employes on this basis.

The wages will be fixed at a certain date according to the cost of living as deduced from the retail prices of a selected list of commodities.

From time to time wages will be readjusted in accordance with the variation in the selected indexes, the items of which are "weighted" or given greater or less effect in proportion to their bearing on the family budget.

If the cost of living goes up, so do the contents of the pay envelope. If the commodity market — and I suppose the index list includes rent, medical service and other items than clothing and sustenance — goes down, the payroll is reduced accordingly.

Suppose that all employers did this, and all labor of all classes, executive and manual, white-collar as well as overall, was paid in this way.

If the cost of living went up, so would the income of labor.

But so would the *cost* of labor.

And, on a basis of cost plus a fair profit, so would the selling price of everything; for there is nothing the production and distribution of which is not chargeable in the last analysis practically entirely to labor.

And then there would have to be more adjustment — upward; and when the janitor got a salary equal to that of the present bank president, he could get no more of the comforts and enjoyments of life with it than he can with his present stipend.

And the provident man who has something put away for his declining years would see the purchasing power of his savings fade away with each boost that the payroll got.

Labor has for years been trying to lift itself into the saddle by successive increments to the wage scale; and with every increment the saddle goes a little higher too.

F. R. Low

Southern Bleachery Installs Steam Plant In Hydro-Electric District

When Constructing the New Bleachery Mill, the Management Decided to Install a Combined Power and Steam-Heating Plant—Horizontal Tubular Boilers and Superheaters Are Used—Steam Extracted from a 750-Kw. Turbine at 40-lb. Gage

THE INSTALLATION of a generating plant by the Southern Bleachery, Inc., when building its works at Taylor, S. C., is indicative of the present trend in Southern textile mills. At the time when the textile companies were moving to the South, the cheapness of hydro-electric power and the desire to avoid all unnecessary investments were the influences that caused the majority of the mills to dispense with generating plants. Even though steam was needed for various processes, many mills used purchased current, although they installed boilers for process steam, and it was contended that the process steam and the electrical demands were seldom in phase. The plan of bleeding the receiver of a compound engine had been practiced, as had also the operation of one end of an engine cylinder condensing, with the other end exhausting at the pressure needed in the process-steam lines. These arrangements were by no means ideal, and the partial use of the prime movers' steam was rather difficult to obtain until the commercial development of the extraction-type steam turbine. It is therefore not surprising that many of the older mills use live steam for heating, etc., and the tendency of new works, such as the Southern Bleachery, to use extraction steam is but the adoption of improvements in power machinery.

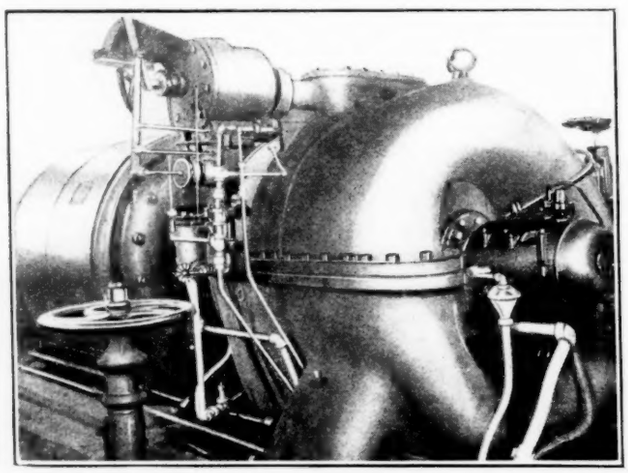


Fig. 1—750-kw. turbine is fitted with extraction mechanism

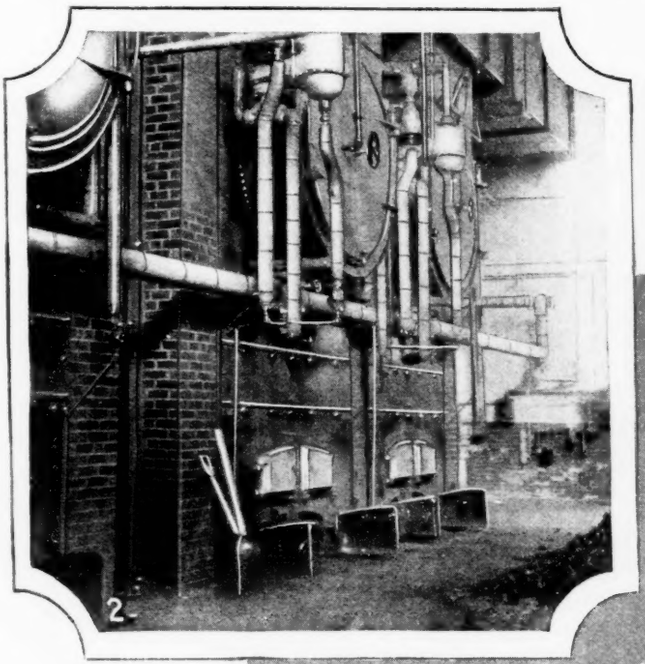
One of the rather startling features of the plant is the boiler installation. There are four 78-in. x 20-ft. horizontal return-tubular boilers, built for 150 lb. working pressure and equipped with superheaters in the combustion spaces at the rear to raise the steam temperature 100 deg. F. The boiler shells are set 6 ft. above the level of the shaking grates. Each unit is provided with an automatic feed-water regulator, and, as shown in Fig. 2, the plan of conserving heat has been carried to the point that the feed-water lines are covered with insulation. Soot blowers are fitted to the front heads, the revolving arms being carried through the smoke doors, so that the blower arms can be turned by a chain and wheel. Hand firing is followed, two firemen handling the four boilers, with a coal passer to wheel the fuel from the storage outside the building.

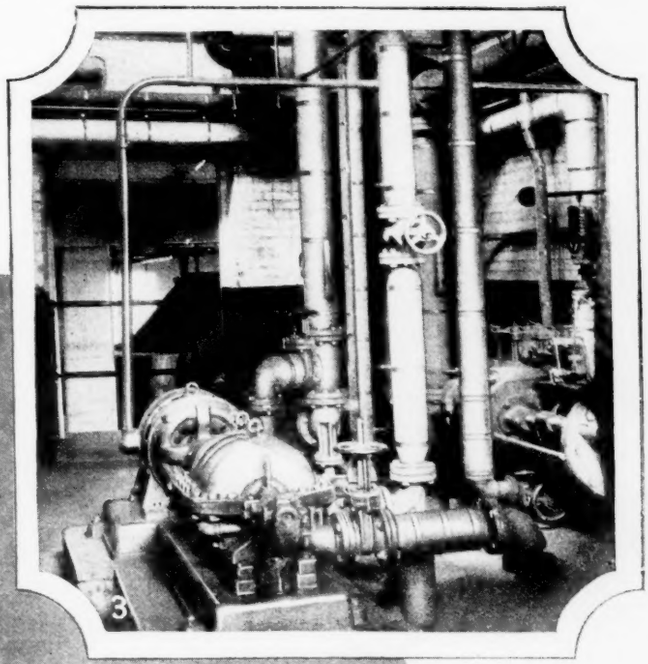
The suitability of fire-tube boilers in such a plant may be questioned by some. The management felt that in view of the character of the available labor, hand firing would be more practical. Due to the greater water volume of the fire-tube boilers, variation in firing, etc., would not have so marked an effect on the steam pressure as would be the case with water-tube boilers. The investment is also considerably less, for tubular boilers can be obtained at around $1.20 per square foot of heating surface, whereas a water-tube boiler costs approximately $2 per square foot f.o.b. cars.

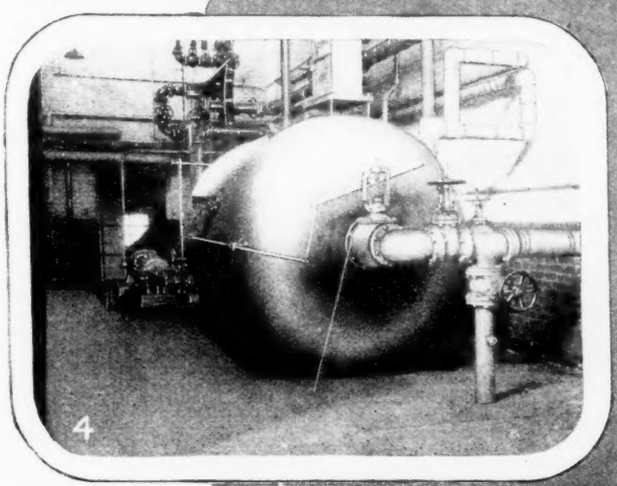
The condensate from the steam lines in the mill and the condensate from the turbine are returned to the receiving tank, shown in Fig. 4. This receiver is provided with a float, which, by operating a valve in the make-up line, keeps the water level constant. It also is divided by a partition containing a V-notch weir, with the recording mechanism located on top of the tank. The presence of this receiver permits any amount of condensate to be accommodated without loss through the overflow. The returns are under several pounds pressure, and it has been found that the drop to the tank pressure, the latter being atmospheric, causes some of the water to flash into steam. The steam bubbles decrease the density of the water, making the weir readings somewhat inaccurate. It is planned to install an open tank above the receiver, so that all flashes will occur in the open tank.

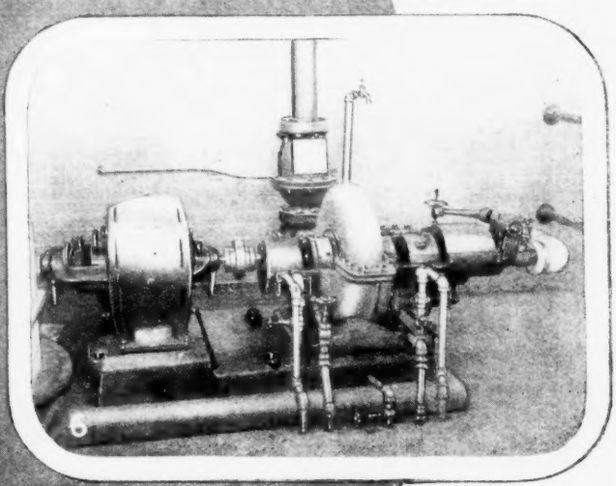
From the receiver a four-stage 2-in. motor-driven centrifugal pump forces the feed water through a closed heater into the boilers. Steam is withdrawn from the extraction steam line at 40 lb. for the heater. By the use of the closed heater, the feed-water temperature can be carried much above 212 deg. F. There is, in addition, a duplex steam-driven boiler feed pump for stand-by service. The 2½-in. low-pressure steam line to the heater is equipped with a thermostatically operated control valve, the element being placed in the feed line above the pump. The exhaust from the stand-by exciter set also enters the heater line, and a 6-in. atmospheric line extending through the roof has a back-pressure valve to maintain the heater pressure constant.

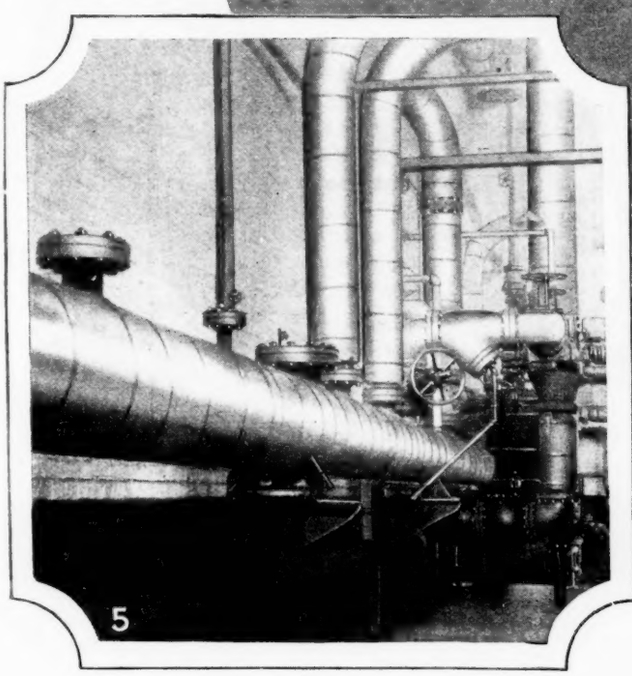
The steam header runs along behind the boilers and is supported on roller brackets. The various nozzles are welded into the pipe. All of the major pipe lines











Important Features of the Plant

Fig. 2—Bleachery uses fire-tube boilers hand fired

Fig. 3—Pipe connections at the motor-driven centrifugal feed pump

Fig. 4—Returns enter receiver, which contains a V-notch weir

Fig. 5—Steam main, which is behind the boilers, has all welded nozzles

Fig. 6—Non-condensing turbine drives 15-kw. stand-by exciter

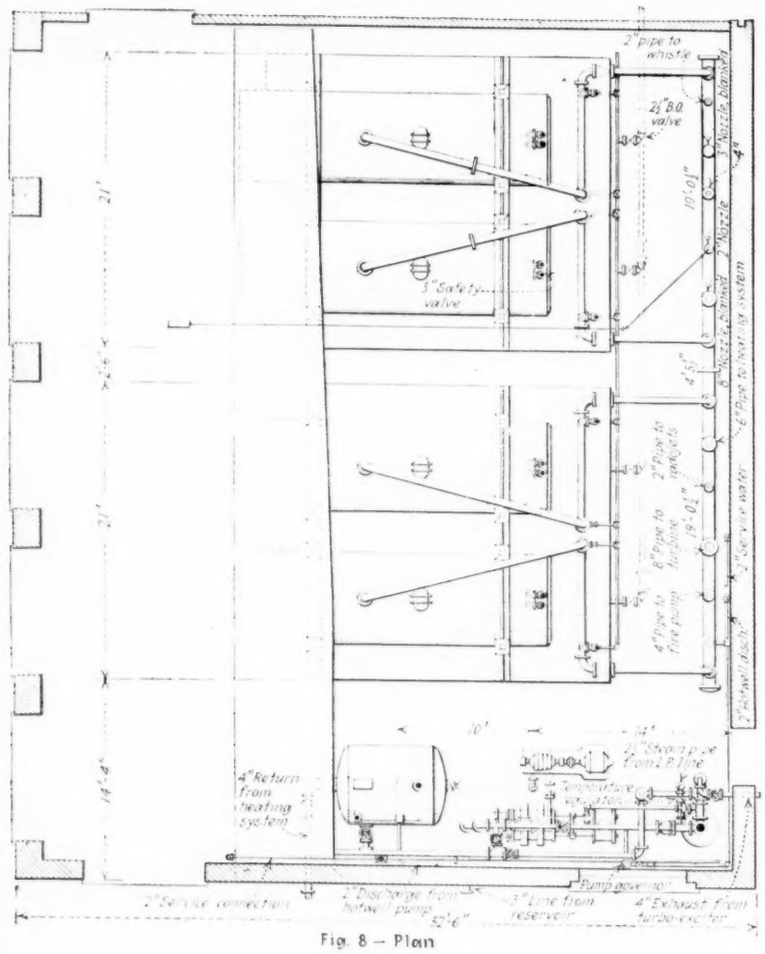


Fig. 8 — Plan

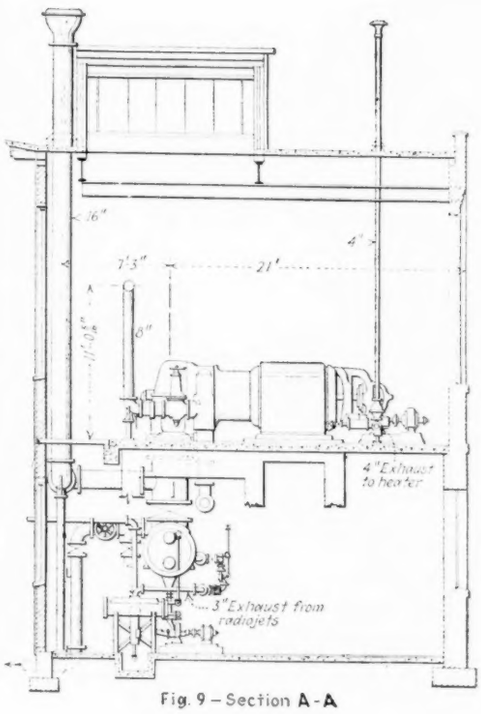


Fig. 9 — Section A-A

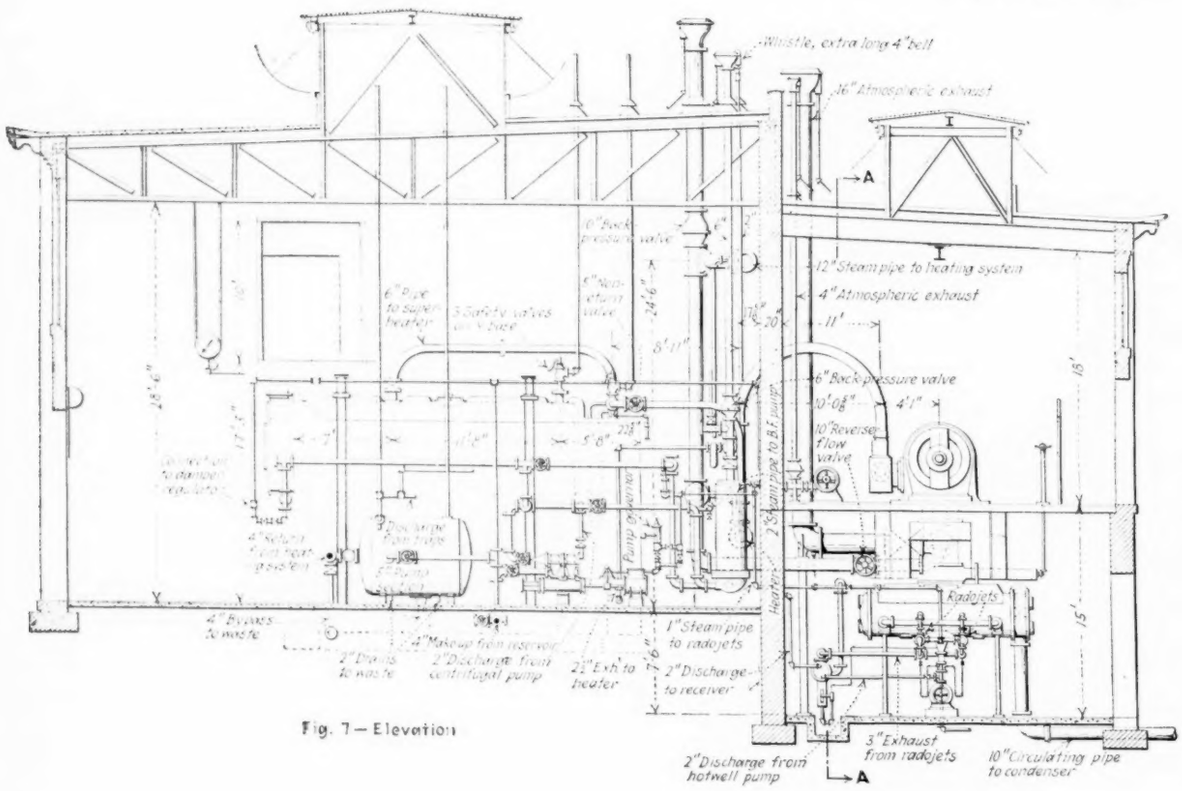

Whistle, extra long 4" bell
16" Atmospheric exhaust
12" Steam pipe to heating system
4" Atmospheric exhaust
6" Back pressure valve
10" Reverse flow valve
Radojets
1" Steam pipe to radojets
2" Discharge to receiver
2" Discharge from hotwell pump
3" Exhaust from radojets
10" Circulating pipe to condenser

Fig. 7 — Elevation

Plan, elevation and section of power plant

have Van Stone joints with straight machined faces and Monel gaskets. Forged steel flanges and high-tensile-strength bolts are used.

The turbine is a 750-kw., three-stage, extraction-type unit, steam being bled at 40-lb. gage. As will be seen from Fig. 7, the extraction line, after leaving the turbine, runs horizontally into the boiler room at the rear of the boiler settings and then upward until it connects with the steam main going into the bleachery. As protection against overpressure, there is an atmospheric vent and a back-pressure valve to relieve at 40 lb.

The surface-type condenser, with duplicate radiojet air pumps, and an after-condenser, are placed in the turbine-room basement. The condensing water is obtained from the adjacent river, being handled by two 1,800-gal.-per-minute motor-driven centrifugal pumps located in a pump house outside of power plant. The condensing water, after leaving the condenser, flows into a service tank on a hill above the mill and is then used for general mill purposes. The condensate is handled by a 2-in. motor-driven centrifugal pump, which forces the condensate through the radiojet after-condenser into the receiver tank in the boiler room.

As a stand-by unit, a 15-kw. 3600-r.p.m. turbo-generator set is installed in the turbine room. There is, in addition, a duplex steam-driven fire pump, located in a pit adjoining the power plant. J. E. Sirrine & Co., Greenville, S. C., were the consulting engineers.

PRINCIPAL EQUIPMENT OF SOUTHERN BLEACHERY

Boilers (4), Type	Horizontal fire tube
Size	78 in. x 20 ft.
Tube dia., in.	3½
Pressure, lb. gage	150
Make	R. D. Cole
Superheater, Make	The Superheater Co.
Superheat, deg. F.	100
Grates, Type	Shaking
Make	McClave-Brooks
Stack, Brick	125 ft. x 8 ft. 6 in. at top
Make	Rust Engineering Co.
Damper control	Mason Regulator Co.
Piping	Grinnel Co.
Flange gaskets (Monel metal)	Akron Metallic Gasket Co.
Pipe covering	Philip-Carey Co.
Feed-water regulator	Stets Co.
Soot blowers	Diamond Power Spec. Corp.
Water columns (Reliance)	Wright-Austin Co.
Blow-off valves	Lunkenheimer Co.
Non-return valve	Edwards Valve Co.
Boiler-feed pump, type	4-stage Centrifugal
Size, in.	9
Make	Dayton-Dowd
Drive	30 hp. 1,750 r.p.m. Westinghouse motor
Boiler-feed pumps, stand-by	Duplex steam
Size	10x6x12
Make	Worthington, Pump & Mach. Corp.
Feed-water heater, type	Closed
Make	Patterson-Kelly Co.
Receiver and meter	Cochrane Corp.
Thermostatic feed control	Fulton & Co.
Traps valve	Valve Engineering Co.
Back-pressure valve, Reducing valves	Fisher Gov. Co.
Turbine return flow valves	Atwood & Morril
Turbine capacity, kw.	750
Type	Extraction
Make	Gen. Elec. Co.
Condenser, Hot well pump, Radiojet air pump	C. H. Wheeler Mfg. Co.
Condensing water pump, capy. each	1,800 g.p.m.
Make	De Laval Steam Turbine
Exhaust heads	Swartwont Co.
Recording pressure gages	American S. & B. Corp.
Steam and water valve	Chapman Valve Co., Lunkenheimer Co.

TYPE METAL has been used for filling in the pitted areas on hydraulic-turbine buckets. A mold was made to fit around the cavity and the molten metal was poured into place, and peened after solidifying.

ALL DAMPERS AND DEFLECTORS IN FAN DUCTS should be held securely in place so as to avoid any rattle or other sounds that might otherwise be produced.

Lubrication of Electric Machinery

BY CLAIR L. KEENE*

DEPENDABILITY, continuity of service and the economical operation of electrical machines depend upon correct lubrication of the unit, the use of correctly selected oil and the maintenance of the purity of that oil by proper care and inspection. Incorrect lubrication causes troubles, wear and repairs, depreciation of equipment and the expense of replacement.

Bearing troubles make themselves manifest in a number of ways, each trouble resulting from one or more of several causes. One of the most common sources of trouble is the use of an oil that is either too heavy or too light in body for the existing conditions. The service conditions must be met by an oil possessing specific characteristics. High speeds, light pressures, low temperatures and good film-forming conditions require an oil of comparatively light body. For slow speeds, heavy pressures, high temperatures and poor filming conditions a heavier-bodied oil is needed. The correctness of an oil can best be judged only by the actual service it renders under the operating conditions, although much valuable assistance can be obtained from the lubrication engineers of the larger companies.

Overheating of bearings may be due to worn-out or dirty oil, not enough oil, sticking rings, rough shaft, excessive pressures or end thrust, or abnormal belt tension. The remedies for most of these causes are obvious. Oil should be kept clean and inspected frequently for signs of becoming worn out or losing its body or of becoming dirty. Foreign substances in an oil, whether they be solid or liquid, result quickly in the breakdown of the oil film, with the consequent scoring of the metal surfaces of the bearing. Oil should be carefully protected from dirt, grit and water, and from mixing with other oils. Bearings, vents and openings, oil holes and oilers should be examined occasionally and cleaned of sediment. Sticking oil rings should be roughened slightly. If forced lubrication is used, care should be taken to prevent dirt and water from getting into the system.

For rough bearings or where there are excessive local pressures, the babbitt or bearing metal should be scraped to remove the high spots and the side clearance increased. Roughness of the bearings may be due to grit in the oil or to currents flowing from shaft to bearing during a flashover or during a breakdown of the insulation shim under the bearing pedestal. This current is usually the result of leakage flux being cut by the armature spider and the shaft. This current causes pitting and scoring of the bearing, which gradually spreads, due to the rough steel surface dragging small bits of babbitt with it. Where trouble is being experienced with bearing currents, one of the bearing pedestals or pillow blocks should be carefully insulated.

"A WORD IN FAVOR OF THE INDEPENDENT POWER PLANT" is the title of a booklet just issued by W. C. Mountain, Son & Wood, consulting engineers, Sun Building, Newcastle-on-the-Tyne, England. It exemplifies the point of view of an English advocate of the isolated plant.

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Care of Transformer Oil

General Practice in Making Tests on the Oil and Type of Equipment Used—How To Tell When the Oil Is in Good Condition—Taking Samples of the Oil—Cleaning the Transformer and Tank—Methods of Purifying the Oil

By FRED C. DeWEESE

OIL USED in high-voltage transformers must be maintained at a high dielectric strength and also be kept practically free from sludge and foreign matter of all kind. It is considered good practice to test the oil in transformers of 100-kva. capacity and larger about twice a year for dielectric strength. The writer believes the most satisfactory method of making these tests is by means of a small portable oil-testing transformer, which can be taken on the job, and a sufficient number of tests can be made to make sure that the condition of the oil is actually known. These testing transformers have a range of 15,000 to 33,000 volts on the high-voltage side; the low-voltage is rated at 110 volts, for connection to the standard lighting socket. The receptacle for testing the oil contains two circular-disk electrodes 1 in. in diameter and for standard work are set 0.1 in. apart.

It is usually more satisfactory to make the oil tests in the field rather than to draw samples of oil to be taken to a laboratory for testing. If the samples are taken to a laboratory for testing, it will be necessary to handle the oil one more time than if the test is made in the field, with the added danger of moisture entering the oil while handling. Not only this, but the sample of oil is often not of sufficient quantity to allow the running of a sufficient number of tests to be absolutely sure of its condition. The writer follows the practice of having the oil drawn directly into the testing cup in which it is to be tested, thus reducing to a minimum the danger of moisture entering the oil during the process of sampling and testing.

The foregoing mentioned type of testing transformer is not suitable for laboratory use, where accurate results are required, as it will not indicate the actual dielectric strength of the oil. It is, however, suitable for field use, as it will show when the oil is safe for operating conditions, and that is all the men in the field care to know. For instance, if the oil under test shows a breakdown at 19,500 volts, but stands up at 15,000 volts, this would indicate that the dielectric strength is somewhere between these two points and would not be considered safe for operating practice, especially if the transformer is of the high-voltage type. On the other hand, if the oil stands up at 24,000 and breaks down at 28,500 volts, it would indicate that the oil is in good condition and filtering would not be necessary.

There is a small gage 0.1 in. in diameter accompanying the oil-testing instrument, to be used for setting the electrodes. There will also be found a book of instructions, which should be followed carefully until the operator becomes familiar with the equipment.

The operator should be careful not to remain too close to the instrument while making a test unless the testing transformer case is grounded. The writer had the experience of having a discharge from the terminals of the test set jump about 12 in., striking him in the leg just below the knee, while making a test at 33,000 volts.

In making tests for dielectric strength of oil, experience has shown that oil containing any considerable amount of dirt and sludge will break down at a lower voltage than its actual dielectric strength would justify. This is due to the fact that small particles of dirt will cling to the surface of the electrodes and also be held in suspension between them, thus causing the oil to puncture, when as a matter of fact it was the dirt that punctured and not the oil. This kind of a conditions may be determined by drawing a sample of oil from a transformer, and if the oil contains any considerable amount of sludge, run a test and make note of the puncture voltage. Then allow a part of the oil from which the test was made to stand long enough for the sludge to settle, and again run a test from the same sample of oil, using for the test oil taken from above the sludge.

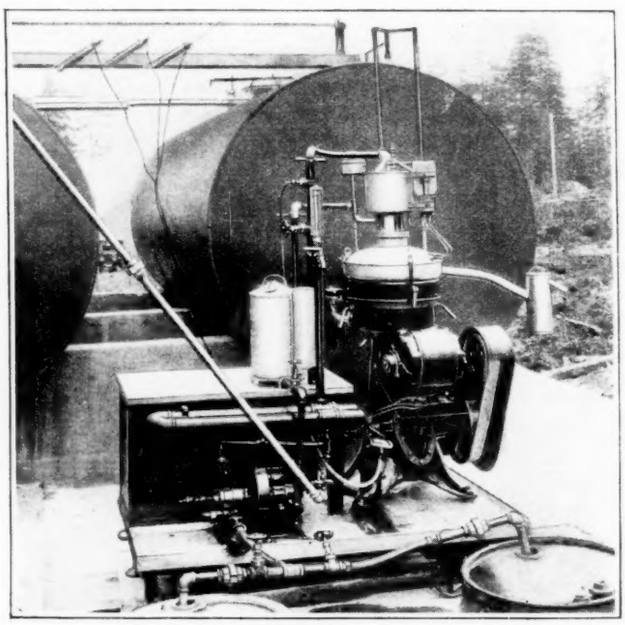


Fig. 1—Conservator-type transformer-oil purifier, connected for operation

Before making a test of the oil the gage should be inserted between the electrodes, for the double purpose of testing the setting and wiping off any air bubbles or particles of dirt that may be lodged on their surfaces.

When a sample of oil is to be drawn from a transformer, enough should be allowed to run out to wash away any particles of dirt or water that may be lodged in the valve and connections. After this has been done, draw a sample of oil for testing and continue the tests

until a uniform result is obtained. This will usually require from three to five tests.

Practically all transformers of modern design are equipped with valves to facilitate the sampling and filtering of the oil. The connections may readily be made without taking the transformer out of service. With the flexible connections, now available, the time required for connecting up the purifier has been materially reduced from that required when ordinary pipe is used. When using ordinary pipe for the filter connections, it is usually necessary to do quite a lot of cutting and threading before the work of filtering can proceed.

A very small amount of moisture in oil greatly lowers its dielectric strength, and if possible, when it is found necessary to filter, the oil should be brought up to 28,500 volts. However, oil that has been in use for some time in heavily loaded transformers sometimes cannot be brought that high, but if it can be brought to 24,000 volts, it may be considered as very good oil and safe for any kind of operating conditions.

It is a well-known fact that many of the older transformers have been in service several years without the oil being filtered. When a transformer has been in service for any great length of time, the oil may become more or less full of sludge and dirt. This will settle on the terminal boards, coils, laminations, etc., with a consequent increase in the heating of the windings and a lowering of efficiency. When a transformer is allowed to get in this condition, it is advisable to take it out of service, drain the oil from the tank, remove the transformer from the tank and wash both the tank and the core with gasoline. The oil drained from the tank should be allowed to settle before it is filtered. During the filtering process the oil should preferably be taken from a few inches above the bottom of the tank, in order that the heavy sludge will not be drawn into the filter.

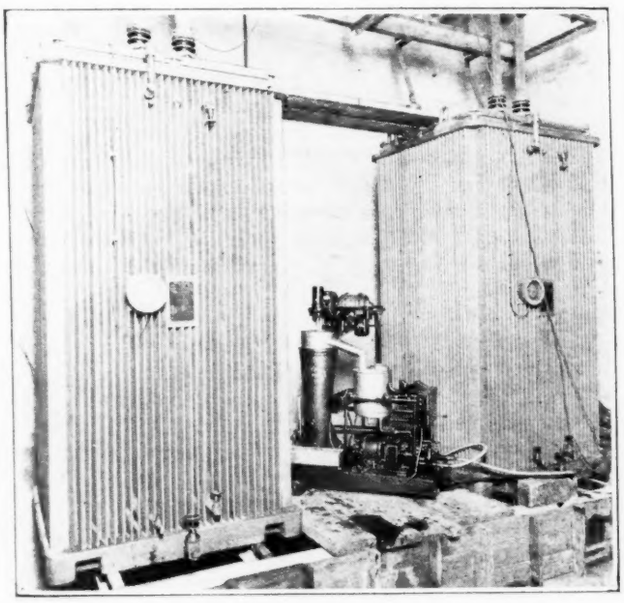


Fig. 2—Portable-type oil purifier connected to a power transformer

When a transformer has been standing idle for some time, it will usually be found that tests made of the oil drawn from the bottom of the tank will break down at a low voltage. This should not always be taken as a criterion of the condition of the oil, as a large part of the moisture that would be held in suspension while the transformer is in operation will settle to the bottom of the tank when it is standing idle. When the transformer is idle, the cover can usually be removed to allow a sample of oil to be taken from the top. The sample should preferably be taken with a small pipe, long enough to reach below the center of the transformer. This pipe should be inserted in the oil along the side of the core. After it is down to the desired depth, both ends being left open while inserting in the oil, the thumb should be placed over the end of the pipe and same withrawn, when a representative sample of oil will be obtained. Care must be exercised in this operation that no injury is inflicted on the coils. All sharp edges and points should be removed from the pipe before it is used for obtaining the oil sample.

For the purpose of keeping both insulating oil and lubricating oil free from sludge and moisture, there has been developed within the last few years what is known as the centrifugal type purifier. This type of purifier is in a large degree taking the place of the filter-press type for dehydrating transformer oil. Fig. 1 shows a De Laval conservator-type transformer-oil purifier connected for operation. This type of purifier excludes the air from coming into contact with the oil during the purification process. Fig. 2 is a Sharples portable-type purifier connected to a power transformer, purifying the oil while the transformer is in service.

Operation of Oil Purifiers

In the operation of the centrifugal type of filter for the purification of transformer oil, two systems are employed. One method is known as the water-seal method and the other is operated without water seal. The water-seal method is used where the oil has a dielectric strength below 15,000 volts and contains a considerable amount of water and sludge. This method permits of a constant discharge of water from the bowl while the machine is in operation. This discharge of water during operation is necessary because of the fact that there is a large quantity of moisture to be extracted from the oil, and unless provision is made for discharging this water during operation, the machine could not operate efficiently for any length of time without the necessity of stopping for removal of the water from the bowl.

For oil of a high dielectric strength, such as that used in high-voltage transformers, the machine is operated without water seal, and there is no discharge of water from the bowl while the machine is in operation.

In assembling the bowl preparatory for use, the instructions of the manufacturer should be followed very carefully. A book of instructions will always be furnished with the purifier, and this should be kept where it is available to the operator.

The frequency of cleaning of the bowl will depend upon the condition of the oil at the start. The amount of oil that should be circulated before cleaning the bowl will depend upon the size of the filter. In the smaller size it will range from 2,000 to 3,000 gal. In the larger size it will be about triple this amount.

The purifier may also be equipped with an immersion electric heater, for the purpose of heating the oil to a temperature suitable for efficient dehydration. The operating temperature should range between 50 and 75 deg. C., and should not be allowed to exceed 75 deg.

The Demand for Overload in the United States*

By C. F. HIRSHFELD
Chief of Research Department, Detroit Edison Co., Detroit, Mich.

THIS is an abstract of one of the "experts' papers" read before the New York meeting of the International Electrotechnical Commission, on April 14, 1926. Most of these deal with electrical technology, but in this paper Mr. Hirshfeld discusses the theory of sizing machines of all types from a general point of view. He points out that the designation of the size of a machine is easily confused with a statement of its capacity, which really depends upon both size and conditions of application, and advocates designating sizes by letters or other symbols not implying performance, with data furnished for determining capacity for any stated operating conditions. If this were done, the term "overload" would cease to be used in many instances.

MANUFACTURED ARTICLES are traded in and referred to in terms of size. Experience has demonstrated that convenience is best served when the system used for sizing possesses certain basic properties: (1) A given size must be capable of simple description or expression (No. 8, 19 hp., 10 lb. per foot); (2) a given size must be capable of verification with minimum effort (linear measurement, simple weighing, or other simple and specific tests); (3) a given size must designate with sufficient (but not superfluous) exactness the article adapted to serve the purposes in view. Greater exactness than this is not needed, and increases production cost.

Systems of sizing should emanate initially from manufacturers. It is primarily their task and to their advantage to determine the sizes demanded by consumers and proper methods of size designation. Maximum benefits will result when the greatest number of manufacturers and consumers agree upon a system of sizing.

Size an Arbitrary Term

In the sense in which the term is used here, *size* is merely a convenient means of designating manufactured articles. It is usually altogether arbitrary, although it may be based upon specific characteristics having to do with the dimensions or performance of the article. Since size is a tool for use in trade, it has a peculiar psychological significance which no one concerned with the choice of a sizing system can afford to ignore.

Certain characteristics of machines have a definite bearing on size determination. Almost every machine has a fairly definite upper limit of possible performance. In this all are alike. Some machines have in addition a definite point of best performance located some distance below the maximum limit. In this machines differ among themselves. A reciprocating steam engine reaches its highest thermal efficiency at a load well below its maximum capacity. It can be run below, at or above its point of best efficiency for so long a time without excessive wear that it may be said to have satisfactory commercial life under any of these three conditions. On the other hand, a steam turbine reaches its best thermal performance at its maximum output. The reciprocating engine may, therefore, be said to possess intrinsically a marked overload capacity, whereas the steam turbine does not, although the equivalent may be obtained by bypassing high-pressure steam to lower-pressure stages. It is obvious that such differing characteristics must necessarily influence decisions with respect to methods of sizing.

Another conception, often confused with *size*, may be designated as *application*. By this term is meant the environment and the conditions of use. Unfortunately, size and application have been confused frequently and extensively. The author believes that a correct differentiation will prove helpful in considerations like that now in hand.

In many cases size has been considered to determine completely the application. Thus a 10-hp. motor is often assumed to be capable of delivering continuously 10 hp. and little, if any, more, regardless of the conditions of use. An excellent example of an exactly opposite condition is furnished by the sizing of structural steel. Here the application is derived from the size by a more or less complicated calculation taking account of the significance of the size designation and the significance of the application requirements. It seems to the author that there need be no confusion between size designation and application if proper choice of method is made. To him it seems that designating a 10-hp. motor as such irrespective of condition of use is at least somewhat similar to designating an I-section as a 10,000-lb. beam irrespective of length or load distribution. In other words, our early practice in size designation with respect to motors appears to have brought about a situation in which size designation is easily and most detrimentally confused with application limitations.

What Is Meant by Normal Load and Rating

The term *overload* implies that there is some normal load. It is therefore pertinent to ask, first, what is meant by this normal load. Presumably the term is what is commonly referred to in connection with electrical machinery as the *rating* of the machine. It appears to the author that this term *rating* as now used is synonymous with what has herein been referred to as *size*. That is, it is a convenient designation for use in commerce, a designation that can be simply stated and readily checked. If this is correct, the existence of overload capacity must mean ability to do

more than is indicated directly by the size designation.

The expression should be used in different senses with respect to different types of equipment. Consider, for instance, the steam turbine. With given steam and back pressure conditions a turbine has a certain maximum capacity and thermal efficiency. Usually the maximum output is raised by bypass valves. Is the size to be designated as the maximum attainable with bypass valves closed and steam conditions most favorable, or is it to be with bypass valves closed and less favorable steam conditions, or is it to be with bypasses wide open and with best or worst steam conditions? Size is easily confused with conditions of application.

The generator driven by this turbine has a maximum capacity usually determined by hot spot temperature. Sustained high temperature is more significant than occasional rises of short duration. Is the generator to be rated on a kilovolt-ampere basis or a kilowatt basis; and to which of the four possible ratings of the turbine is the generator rating to correspond? Again, application is becoming confused with size designation.

As another example, a motor-generator set or a rotary converter for electric railway service must carry for short periods loads two or more times the continuous capacity of the machine. It may well be that the commutator limits the short-time capacity, whereas the insulation temperature limits continuous capacity. Here again application and size designation are intermingled.

The general purpose motor is commonly sized on the basis of capacity for a designated temperature rise above a designated ambient temperature with continuous load. Is overload capacity to mean ability to operate safely at greater temperature rise above the designated ambient temperature, or is it to mean ability to carry more than the designated load without exceeding the chosen maximum temperature if the existing ambient temperature is lower than that chosen, or is it to mean one or all of several other possibilities?

Margins of Safety Provided by Both Buyer and Builder

Another aspect of overload capacity follows from the fact that in many cases a machine is sold to perform under certain defined conditions. Ordinarily the manufacturer plays safe and supplies a machine designed to be a little larger than specified with intent to guard against limitations due to errors in design and manufacture. Frequently, the customer also is not certain that he will be able to maintain conditions as favorable as those specified, and he therefore asks that the machine be capable of meeting the capacity specified under less favorable conditions. Each of these two practices results in a certain overload capacity that may be regarded as a margin of safety, the first on the part of the manufacturer and the second on the part of the customer.

To set up a simple ideal, let us assume that size designation is primarily nothing but a convenient label, expressed in terms of letters or numbers or the like. To the purchaser the size designation means nothing with respect to capacity unless he knows the key. A purchaser desiring a machine for a given purpose will specify the conditions of application and the manufacturer will choose the size he considers appropriate. The customer will have two choices in preparing his specification. He may specify his most favorable conditions but also insist that the machine be able to deliver the required capacity under less favorable conditions, or he may more logically specify his least favorable conditions and possibly ask what the capacity will be under the more favorable conditions.

Let us now compare this ideal with actual practice in this country. Where sizes are given in terms other than terms of capacity, the actual procedure is much like that outlined. That procedure is also common when the purchaser happens to be one who analyzes his requirements and the machines available. In both cases a certain additional overload is obtained, due to the manufacturer's margin of safety, the customer's margin of safety and, when stock sizes are available, to the choice of the "next larger size."

Where size is expressed in terms of capacity and the purchaser is not possessed of sufficient technical knowledge to appreciate the significance of the limitations assumed, conditions may be different. Some purchasers regularly incline to choose the "next larger size." Others may even order the "next smaller size." Such action, inspired by caution or economy, is in many instances the result of previous experience.

The author's conclusions, presented with full appreciation of their limitations, are:

Conclusions Arrived At

(*a*) The educated buyer in the United States is tending toward the purchase of definite maximum capacity, to be developed under definitely stated conditions, and he expects to obtain only such overload as may result from what has been called the manufacturer's margin of safety plus the margin of safety (if any) that he has included in his own specifications as allowance for any inability to state precisely his least favorable conditions of use.

(*b*) The uneducated buyer is increasing in numbers but probably decreasing as a percentage of the total, and his habits depend largely on his personal characteristics. In general he can be guided to purchase on any basis that a trained salesman can show to be to the purchaser's interest.

(*c*) There is a well-recognized tendency in this country to play safe in case of doubt. This leads both educated and uneducated buyers to follow a purchase method leading to the acquisition of overload capacity, but this is the product of a factor of ignorance, and is not an intended and definitely determined increment.

There is no doubt in the mind of the author with respect to the trend of the immediate future. The increasing use of technically trained engineers combined with increasingly severe competition in local and world markets will inevitably lead to a more extensive analysis of requirements in individual cases, with resultant purchase on a correspondingly exact basis. A demand for overload capacity (in the simple interpretation of that term) must gradually disappear. There will, of course, always be cases where short-time overload capacity will be required. However, it seems wrong to the author to describe such requirements as overload capacity. In fact, the machine in the case cited above (the railway converter) has different capacities for different periods of operation, and a rational method of specification would treat the matter in this way.

As an example, consider the rating of the general purpose motor. Sizing is on the basis of rating, in that motors are sold in terms of what is assumed to be their normal maximum output in horsepower. One

group believes in rating on the basis of a 40-deg. C. rise above a 40 deg. C. ambient temperature, whereas others hold to a 50 deg. rise above 40 deg. A comprehensive survey should determine which method of sizing is commercially preferable. The only efforts in this direction appear to demonstrate the superiority of the 50 deg. choice.

It is the author's opinion that what may be called the overload capacity in the 40 deg. rated motor now made and sold in this country greatly exceeds any reasonable commercial margin of safety. That is, these machines are in most cases operating under such conditions that they do not make the best use of the money invested in them or in the equipment supplying them with power. In this sense the present method of sizing appears to put an unnecessary financial burden on society and to retard in this way the more widespread and economical use of electric power.

Sizing Boiler in Terms of Boiler Horsepower

It happens that we started to express the size of motors in terms of capacity. We are now confronted with a logical result—namely, the inadequacy of our sizing formula and expression to take care of innumerable variations in application. This phenomenon is not new. In this country we adopted long ago the practice of sizing boilers in terms of boiler horsepower. The practice had certain advantages at the time and probably served a useful purpose, but it is now so ridiculously far removed from either rationality or usefulness that it is in the process of being abandoned in favor of more useful and convenient methods. There is a striking parallel in these two cases. To the author it seems that we should agree on certain standards of service, and that a given size of motor would not have a definite standard rating, but would be rated for the purpose of sale upon the basis of stipulated conditions of use. Naturally, tables or diagrams would have to be used to determine the rating of any given size under any specified conditions. Sizes would be preferably expressed in terms other than horsepower.

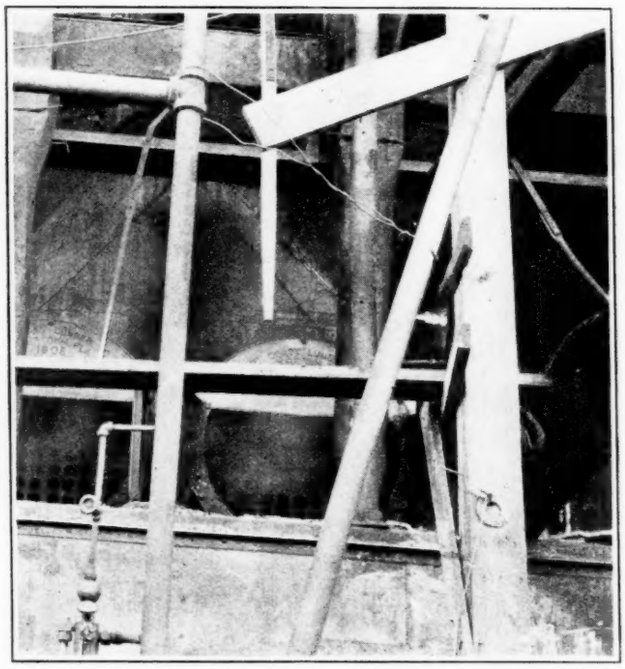
Whether or not we travel any such route as that just indicated, the author wishes to make an earnest plea that an attempt be made to base decisions with respect to rating for purposes of selling upon determined facts with respect to the majority conditions of use rather than upon the personal impression of different individuals. He would like to see illogical and irrational methods of sizing abandoned. Sizing that leads to confusion with respect to selling is certainly undesirable and should be avoided.

"With a 20-Deg. Difference between the dew-point saturation temperature and room temperature, you have practically 50 per cent humidity, and it does not matter whether you start with a 30-deg. dew-point or a 90-deg. dew-point, the law holds approximately true." This relation, which was pointed out by W. H. Carrier at the annual meeting of the American Society of Heating and Ventilating Engineers in January, is worth remembering. The dew-point of the air in a room can be roughly determined by the gradual addition of ice water (stirring constantly) to warmer water in a metal pitcher until dew just begins to form on the polished surface. The temperature of the water when dew forms may be taken as the approximate dew-point. If this occurs at a temperature about 20 deg. below that of the room, the humidity is about 50 per cent.

A Smoke Door Makes a Poor Draft Regulator

In the illustration is shown a condition that exists in many plants, and one that should not be permitted by the management if the engineer does not appreciate its shortcomings.

In a lumber mill of considerable size the boiler smoke uptakes are not provided with dampers. When the plant shuts down at noon or at other times, the only way to control the combustion of the hogged fuel in the



One way to control boiler draft

Dutch ovens is the opening of the smoke doors of the boilers. It must be admitted that the draft is effectually dampened, but the expense of re-rolling leaky tubes would more than pay for the highest-grade damper device.

Both the Interior and Exterior of Electric Machines should be kept free from water, oil, dirt or grease. For machines installed in very dirty places, trouble may be averted by periodically removing the rotor or armature and thoroughly cleaning the machine. A vacuum cleaner is highly recommended for cleaning assembled machines. The use of compressed air is not recommended on assembled alternating-current motors. It is especially objectionable on machines installed in foundries, machine shops or locations where there is much carbon dust, metallic chips, etc., as the compressed air may drive the dirt or metallic chips into the windings and cause breakdowns. On direct-current machines the use of compressed air is not objectionable, because all parts are more or less accessible, especially the commutator and brushes.—*Instructions of the Electric Power Club.*

The Acid Content of Sludge, the latter a product of oxidation, is always many times greater than the acid content of the oil in which the sludge is formed.

New Refrigerating Plant to Ice Florida Orange Cars

FEDERAL ICE REFRIGERATING CO. installs electrically driven ice plant of 500-ton capacity at Sanford, Fla. Compressors are of the horizontal double-acting type. Simplified piping system. Plant is completely motorized.

THE problem of car icing is one of the most serious confronting the transportation companies and the shippers of Florida. The cost of bunkering refrigerating cars is one of the large items in the differential between the price paid to the grower of fruits, such as oranges, and the price paid by the ultimate consumer. To bring these closer together requires that the ice-making plants be designed to operate

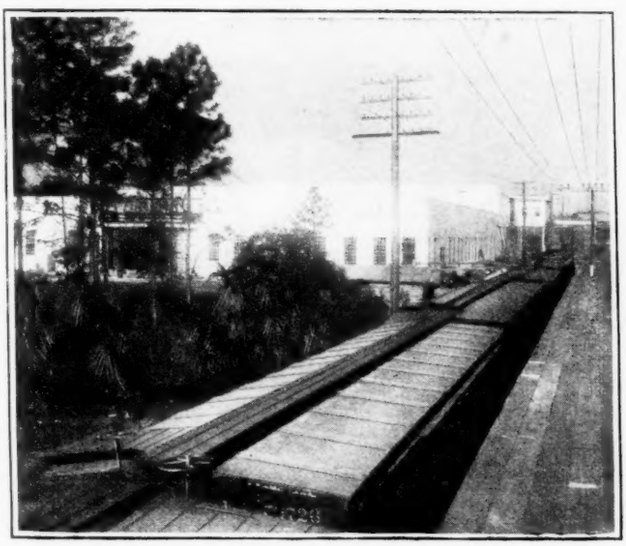


Fig. 1—Plant building viewed from the track side

economically. Plants that are quite satisfactory as long as the output is used in the homes, are too expensive to operate when the product is wholesaled or devoted to car icing. These factors have led to the installation in Florida of refrigerating plants whose equipment is not only modern, but compares more than favorably with plants in the large Northern cities.

An outstanding example of these better plants is the one just completed by the Federal Ice Refrigerating Co. at Sanford, Florida, the output of which will be used to ice cars for the Atlantic Coast Line Railway. When planning this installation, the practice of installing oil engines, followed in many of this company's Southern plants, was abandoned, for the reason that the local electric utility company offered an electrical energy rate that was somewhat lower than the total cost of operating with Diesel engines. The car-icing demand exists only during part of the year, at which time the plant must run at maximum capacity. During the summer months the output will consist in the main of household and peddler ice, making the annual load factor low. The overhead charges on the oil engines would continue even though the plant was only partly loaded; and on such a variable load the electrical installation works out more favorably in this case.

The plant building is of concrete with a wash, or

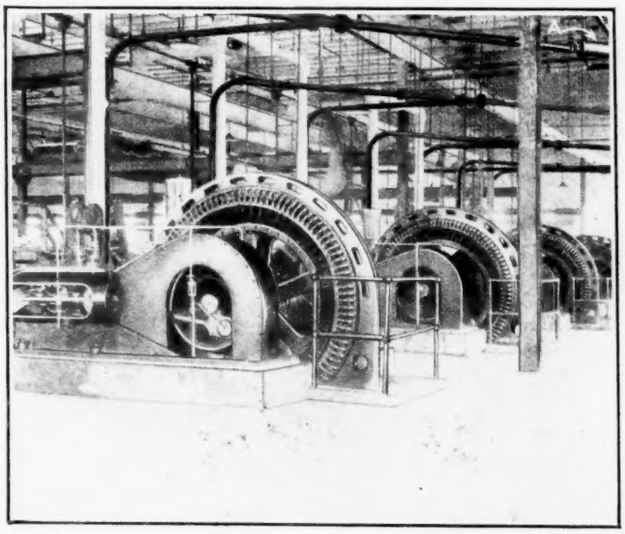


Fig. 2—The four compressors are motor-driven

stucco, exterior finish. The compressor and ice tank room is one story in height, while the ice-storage portion is two stories high, with the ice stored on the second floor. The building is most pleasing in appearance and, set as it is among pines and palms, has little of the appearance of a manufacturing plant.

The compressors, four in number, are placed in line down the compressor end of the building, as shown in Figs. 2 and 3. Each of the units is made up of two horizontal 10½x24-in. double-acting cylinders operating at 120 r.p.m., with the driving synchronous motor placed on the compressor shaft between the two rolling-mill type frames. The cylinders are provided with standard Ball open-top box water jackets. The valves are of the light-poppet design; each head contains three suction and three discharge valves.

The oiling is by gravity feed from a small filter tank mounted above the frame. The used oil drains to the crank pit and is returned to the filter by a rotary pump, belt-driven from the compressor crankshaft. In addition to the gravity oil line, the stuffing box is equipped with a hand oil pump discharging into the lantern. Liquid injection is not used, but such a line

is run to the lantern for cooling purposes in case the rod gets hot.

Although the compressors are rated at but 100 tons each, the management expects to obtain a total of 500 tons. For excitation there are 3 motor-generator sets, the driving motors taking current at 440 volts. These sets are placed along one side of the building in line with the 11-panel switchboard. A main switch panel, 4 compressor-motor panels, 2 exciter panels, 3 feeder panels for pump motors, etc., and a blank panel make up the assembly.

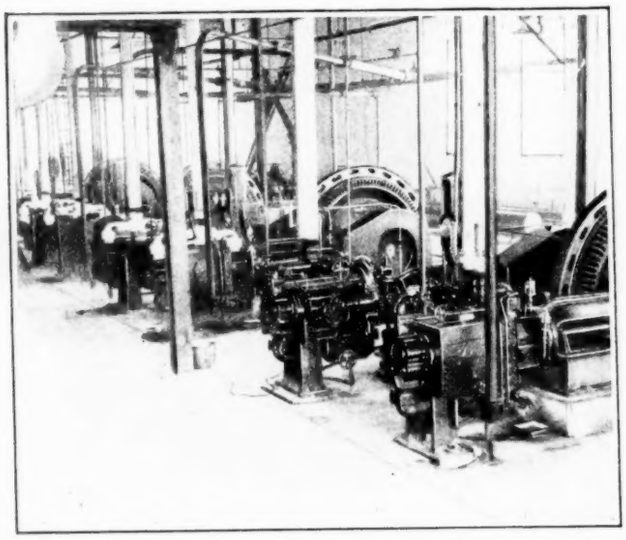


Fig. 3—Compressors as viewed from the ice tank

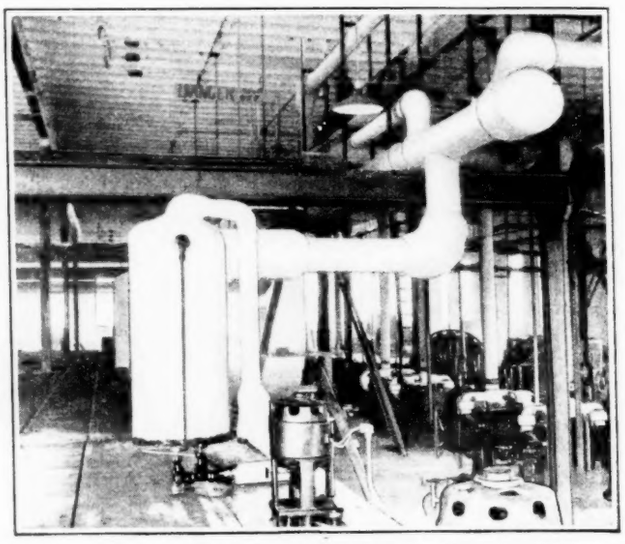


Fig. 5—Accumulators and piping to the compressors

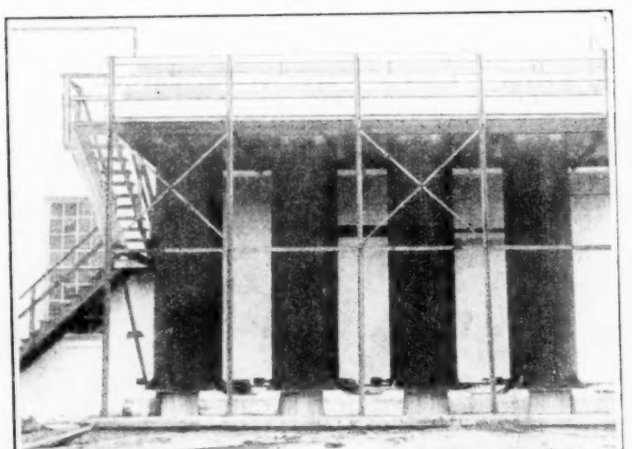


Fig. 4—Four shell-and-tube condensers are outside the building

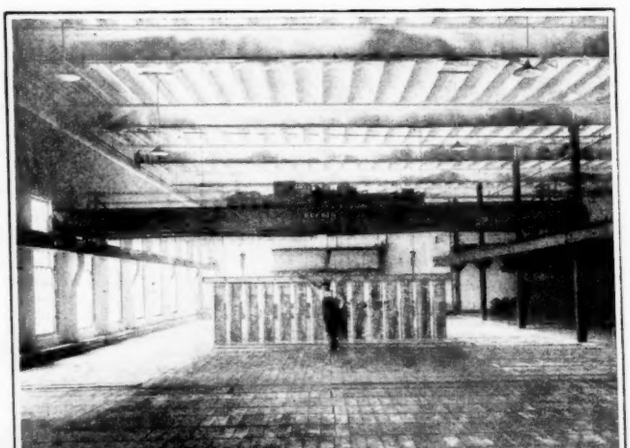


Fig. 6—One of the three ice tanks with the can hoist in background

The 2½-in. discharge line from each cylinder rises vertically and then runs horizontally to a Y-connection joining the lines of the two cylinders of each unit. From this Y-connection the line is 4 in. in diameter until it connects by a similar fitting to an 8-in. header running along the south wall of the building. This header has a connection leading to each of the four vertical shell-and-tube condensers, placed just outside of the south wall, as shown in Fig. 4. The liquid return line from each condenser is connected to a header inside the building approximately 2 ft. above the floor line. This header runs to the two 24-in. by 18-ft. welded receivers placed on the compressor-room floor.

Water for the condensers is obtained from a deep well, the water rising to within a few feet of the ground level. A 4-in. motor-driven centrifugal pump lifts the makeup water and delivers it into the spray pond on the roof, whence it flows to the condensers. After flowing down through the condensers, the water drops into a concrete sump and three centrifugal pumps lift it and force it through the 88 two-inch spray nozzles on the roof. Two of these motor-driven pumps are 8 in., and the third is 5 in. One of the 8-in. and the 5-in. pumps deliver into a common discharge line. The 4-in. pump not only supplies the condenser makeup, but also is used to fill the ice-can water-storage tank.

To provide warm water for the dipping tank, each of the four compressor discharge headers is provided with a jacket heater, shown at *A* in Fig. 2. These are

8 in. in diameter and are made up of No. 16 gage steel welded on to the discharge lines. The spaces between the jackets and headers are filled with water tapped off the condenser-pump discharge line, and the heat-transfer surface is sufficient to bring the water from 60 to about 85 deg. F. This temperature is ample for tempering, and so far cracked ice has not appeared.

From the receivers a liquid line runs to the three accumulators, one of which appears in Fig. 5, placed at the ends of the three tanks and connected to the

PRINCIPAL EQUIPMENT OF THE FEDERAL ICE REFRIGERATING COMPANY'S SANFORD PLANT

Ice Machines:	
Number	Four.
Type	Twin horizontal, double-acting.
Size	10½x24 in.
R.p.m.	120.
Drive	Direct connected to synchronous motors.
Make	Ball Ice Machine Co.
Synchronous Motors:	
Size	160 kva., 2,200-volt, 3-phase, 60-cycle.
Make	Gen. Elec. Co.
Exciters	2 25-kw. G.E. 1,740-r.p.m. motor-generator sets. 1 15-kw. 1,800 r.p.m. G.E. set. Gen. Elec. Co.
Switchboard, 11 panel	
Condensers:	
Type	Vertical shell-and-tube.
Size	50 in. x 18 ft. 6 in.
Number	Four.
Make	Henry Vogt.
Air Compressor:	
Type	Horizontal, double-acting.
Make	Penn. Pump & Compressor Co.
Size	10x8 in.
Drive	Belted to 15-hp. G.E. motor.
Propeller Motors:	
Type	Vertical.
Number	12.
Size	3 hp. 860 r.p.m.
Make	Ideal Elec. & Mfg. Co.
Can Hoist Crane:	
Capacity	4-ton.
Make	Euclid.
Spray Nozzles:	
Number	88 2-in.
Make	Spray Engineering Co.
Centrifugal Pumps:	
Number	Three.
Size	2 8-in. 2,000 g.p.m. d.c. to 40 hp. 1,750 r.p.m. G.E. motors. 1 5-in. 1,000 gal. g.p.m. d.c. to 20 hp. 1,750 r.p.m. G.E. motor.
Make	Dayton-Dowd.
Makeup Pump:	
Make	1 4-in. 500 g.p.m. centrifugal d.c. to 15 hp. 1,755 r.p.m. G.E. motor Dayton-Dowd.

evaporating coils. A somewhat new arrangement of hot gas line has been added. Pump-out lines run from the compressor cylinders to conveniently placed loops on the building columns. By closing the liquid line from the receiver, an ammonia shipping cylinder can be discharged into one of the accumulators, and as soon as the pressure in this shipping cylinder drops to the suction pressure, by closing one valve and opening a second, it is disconnected from the liquid line and connected to a compensator pump-out. By closing the compressor cylinder's suction valve and opening the pump-out valve, a vacuum may be drawn on the shipping cylinder and all the ammonia put into the system. The hot gas line permits the coils in any one of the tanks to be cleaned of oil, etc.

Each of the three tanks, Fig. 6, is 38 ft. 4 in. wide by 127 ft. 6 in. long and contain 32 stands of coils 14 pipes high. Three sections with gland and stuffing box make up each stand and are connected to the top pipe which runs the length of the three stands. This arrangement permits any section to be disconnected and removed. No joint exists under brine, as each coil is a continuous piece of pipe. The total length of the 11-in. coils is 54,337 ft., and each tank contains 1,484 cans, made up of 53 rows of 28 cans. The tanks are set on 6 inches of concrete with 12 inches of cork between. The side insulation is made up of a 2-in. and a 3-in. layer of cork.

High-pressure air is used for agitation, the air being supplied by a single-cylinder horizontal compressor motor-driven through a short belt. A dehumidifier using brine for cooling is placed between the compressor and the air header, a 3-in. centrifugal pump circulating the brine. To handle the brine in the ice tanks there are 12 vertical propellers—two being placed at each end of each of the three tanks.

Space has been left on the east side of the floor to accommodate three more tanks and three additional compressors.

This plant is outstanding in its simplicity. The piping is direct and is made up of the fewest possible number of lines. Being overhead, it is in plain sight, so that leaks are easily located and repaired, and at the same time the lighting effect is not hindered. It is the intention to employ, besides the chief engineer, an engineer and an oiler per shift, while two ice pullers will be used on each of the three shifts. This is a rather exceptional arrangement in Florida, for 12-hour shifts are almost standard in the plants of that state.

PRIME MOVER EVOLUTION IN BOSTON—Thirty-three years ago the Edison Electric Illuminating Company of Boston was operating belt-driven generators with an average fuel consumption of 10 lb. of coal per kilowatt-hour. Vertical direct-connected engine-driven generators were then installed, and the fuel requirements rapidly fell during the next four years to half the above value, and in the company's best plant, to about 2.3 lb. The installation of still larger units was followed by increased operating economy, and in 1904, when the early vertical steam turbines began to count in plant efficiency, an even 2 lb. per kilowatt-hour was attained in the company's most modern station. Since then the gain has been gradual but sure, until in the Edgar station at Weymouth, with higher steam pressures and the use of 30,000-kw. steam turbines, the record, as recently announced in *Power*, is just a "hair over" 1 lb. The good influence of improved prime movers on the system production economy is marked.

IF THE CONDENSERS OF A REFRIGERATION SYSTEM ARE DIRTY or covered with moss, mud or scale, the capacity of the entire system will be greatly reduced. Scale is one of the best insulators known. It prevents the cold water from coming into intimate contact with the hot gases. The capacity of the condenser is lowered in direct proportion to the thickness of the scale. Any accumulation in the pan underneath an atmospheric condenser should be removed, as should any moss that may have accumulated on the pipe. The water-distributing ducts or pans should be cleaned and the outlets so proportioned that water flows over the coils in an even stream covering the entire surface of each pipe.

A RECENT SURVEY by *Chemical & Metallurgical Engineering* showed that the chemical engineering industries use three times as much fuel for process steam as for power. This is probably one reason why this group of industries generates 75 per cent of its power, buying only 25 per cent. It might be added that there is apparently a splendid opportunity for the generation of a considerable quantity of byproduct power, through interconnection with local utility systems, with interchange of power.

Using the Torch in the Power Plant—I

Practical Comments on the Welding Outfit Needed in an Average Plant—Points to Be Considered in the Selection and Operation of the Equipment, with Instructions for Making a Weld and Testing for Leaks

By L. A. COWLES*

THERE has been so much discussion, mostly adverse, on the welding of pressure vessels, that it would seem that this was the only use the engineer might have for welding equipment. As a matter of fact, it is the least use he will have for it, as it is the every-day salvage of broken and worn parts that pays the big dividends on the investment.

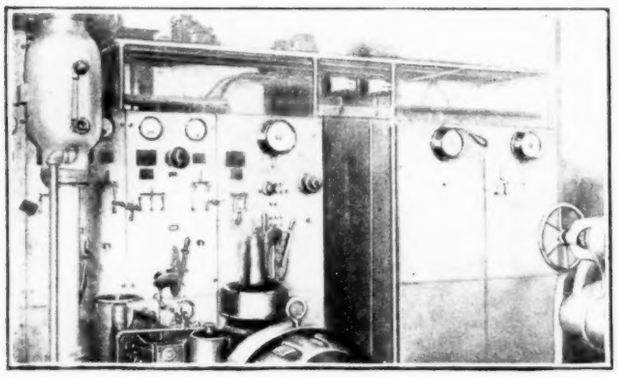


Fig. 1—The frame for this switchboard was made up of pipe welded together

Certain uses for the torch in the power plant were given in an article by the author published in the Jan. 26 issue of *Power*. Since that time the switchboard frame shown in Fig. 1 has been built out of 1¼-in. pipe with this most useful tool.

In the present article a general idea will be given of how to use the welding torch. To begin with, any man capable of operating and maintaining power-plant equipment will find that using the torch is a comparatively easy accomplishment and much to his advantage from a financial standpoint, as well as reducing his labor and worries in the daily business of keeping the plant and tools in condition.

Equipment Needed for Welding

The first thing to consider is some place to put the equipment. Fig. 2 shows the space required. The writer uses one end of the work bench to support a welding table, which can be adjusted to any position. This is not essential, but has some advantages in that the work can be turned as the welding progresses. Pieces of iron that can be used to line up broken parts in position for welding can be picked up in any plant. V-blocks are useful as are also an angle plate and a few iron clamps of various sizes. Figs. 2 and 3 show the writer's outfit, which is all that will be needed in the average plant.

In this welding corner will be noticed an emery wheel, which is considered indispensable, particularly one coarse wheel for the preparation of the piece to be welded. A fine wheel may be provided to finish off the weld for the sake of appearance, or for the examination of the weld for flaws. Where appearance does not count, it is not the writer's practice to smooth up and polish a weld, as this operation merely removes metal and this weakens the weld.

Welding Rods and Flux

An assortment of welding or filler rods will be required. There will be needed cast-iron rods of from $\frac{3}{16}$ to $\frac{3}{8}$ in. diameter, the former being used on small work in conjunction with a small torch tip and the larger rods on heavier work requiring the use of larger tips. The foregoing holds true for steel, except that steel rods are used. For brass or copper alloys, a copper rod having a small percentage of phosphorus is generally used, and two of the smaller sizes are all that are needed.

For brazing, tobin bronze makes a strong weld, so that the brazing or bronze welding of cast-iron pipe and the repairing of cast-iron and malleable-iron parts with bronze are coming into more general use. The weld is stronger than the metal adjacent to it and the expansion strains are reduced.

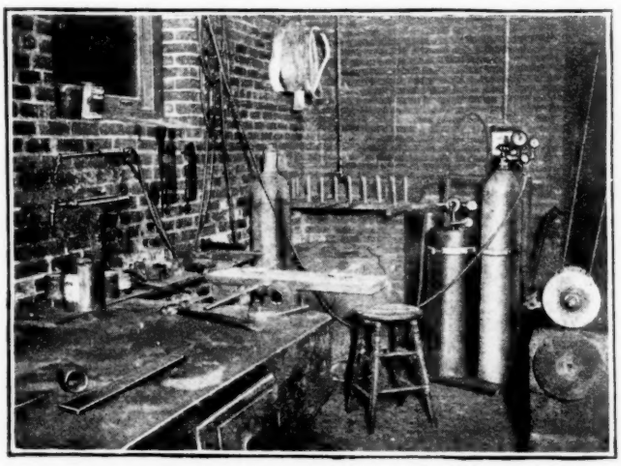


Fig. 2—The corner taken up by the welding equipment is 8x8 ft.

The adjustable welding table can be seen in the foreground. It will be noticed that the hose is kept up off the floor. In the right background are the acetylene cylinders with their regulators, mounted on a truck for portability.

There will be little use for aluminum rods, but to tip brick and stone drills and other cutting tools, a

*Chief Engineer, University of South Dakota, Vermillion, S. D.

metal having the property of red hard, high-speed steel will be needed. This calls for rods going under various trade names.

For convenience, keep the welding rods in a rack within reach. One precaution to be observed is to keep them dry, as rust does not improve the quality of the weld.

Another requirement is a pound each of cast-iron and brazing flux, the flux being used to reduce oxidation by forming a protecting film over the molten metal and acting as a solvent for the oxide already formed. Cast-iron flux is often used when welding steel if the carbon content is high.

A pair of dark glasses will be needed, and it is important that no work with a torch should be done without having them on. Although the oxy-acetylene flame is practically free from injurious rays, the light and heat from the molten metal is harmful to the eyes.

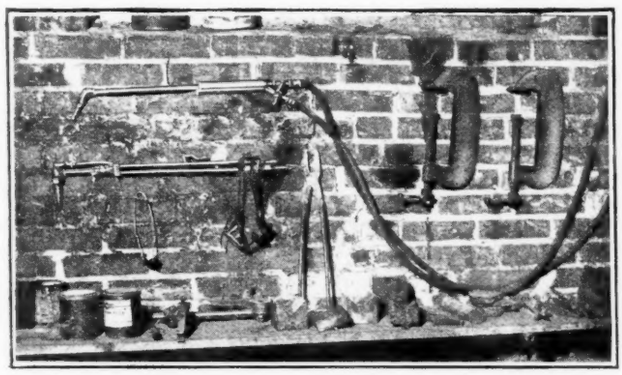


Fig. 3—Tools used in welding

From the top center down, the tools shown are the welding torch, cutting torch and glasses; from left to right are the brazing flux, cast-iron flux, welding clamps, V-blocks, carbon blocks and carbon rods. There will be noticed also a pair of tongs, clamps and friction lighter.

Selecting a Torch

The requisites in selecting a torch are equal consumption of acetylene and oxygen, quality of the material, weight and balance, ease of flame control and a complete set of tips. The equal consumption of the gases has two advantages—namely, saving oxygen and producing a flame without an excess of oxygen (if properly adjusted), which is important in so far as the quality of the weld is concerned. The material and design have a bearing on the lasting qualities of the torch, and the weight, in conjunction with the balance, determines the ease of operation.

Oxygen and Acetylene Regulators

The term regulator will be better understood by engineers if they are called reducing valves, for they are used to reduce the pressure of the gases in the cylinders to a uniform working pressure of about 10 lb. Naturally, the pressure used depends upon the design of the torch, the size of the tip and the piece to be welded. These regulators are important equipment, as the control of the flame from the torch is principally dependent upon them.

Two regulator "don'ts" are: Use no oil and do not leave the regulators under pressure when not in use. Blow out the unions on the cylinders with a little gas before connecting the regulators, as every precaution should be taken to keep out dirt. Any desired information on reducing valves may be obtained from the companies making them, so that there will be no need for going into detail on their construction.

For the connection from the regulator to the torch, the writer uses a 25-ft. hose, specially constructed for this use. It can be secured in various colors. The writer uses black hose for oxygen and red for acetylene in order to guard against mistakes in connections. A short hose about 10 ft. long is generally used. It does not waste so much gas when changing to the cutting torch, or vice versa, as does the long hose; but for repairs on the boiler breachings, pipe lines and cutting out tubes from the boilers, the longer hose is needed.

The supply of gas is so well taken care of by the manufacturers that this item is merely a matter of ordering one cylinder of oxygen and one of acetylene. The cylinders are loaned for thirty days and a small rental charge is made for those kept overtime. The cheapest supply of acetylene gas can be obtained by using a generator and buying the carbide in drums for charging it. That the generators will require some attention must be considered.

Making a Weld

To make a good clean weld it is necessary to melt the metal clear through the break and not leave cold shuts —that is, metal bridged across and leaving holes. To prepare for the welding operation, cut or grind out a V of at least 90 deg. and in the welding of heavy pieces more than this, to be sure that the welding starts at the bottom of the break. This should give room for the torch tip without heating the tip and permit working out the slag with the filler rod. More room in the V is needed in welding steel than is the case with cast iron, as steel sets quickly and the possibility of cold shuts is greater. When welding thick pieces, it may be necessary to V out and weld from both sides.

Testing for Leaks

After connecting the regulators to the cylinders and the hose to the regulators and torch, tests should be made for leaks. Screw the reducing valve handles out to the left, and with the oxygen valve on the torch open, turn on the oxygen cylinder slowly. Have a small tip on the torch. Now adjust the pressure to about 10 lb. or as per directions sent with the torch, shut off the torch and notice whether the regulator holds the pressure constant. If it creeps up, there may be dirt in the valve.

In testing for leaks, the usual practice is to use soap suds brushed over all parts. In making up joints, use soap if necessary, but never use oil or grease; disastrous results may follow. The same process of adjustment and testing is repeated with the acetylene, but here it will not take much of a nose to detect a leak.

Adjusting the Torch

In lighting the torch, turn on the acetylene and light quickly. For economy, the writer uses a torch lighter. If there has been an escape of acetylene into the room it would be best to air the room thoroughly before lighting the torch. With the acetylene ignited, it will be noticed how smoky the flame is and how it fills the air with soot. This is carbon, as acetylene is composed of carbon and hydrogen, and the formation of the soot is due to lack of oxygen for combustion. Turning on the oxygen will supply this deficiency, and complete combustion takes place when the cone of the light blue

flame at the tip of the torch is clear and without a feather of white color being seen in the purple outer flame envelope. When this has been accomplished, stop increasing the flow of oxygen. This procedure is sometimes reversed, the torch being lighted and adjusted to a neutral flame with the acetylene valve, the oxygen valve being entirely open.

The preceding operations will give a neutral flame at a temperature of more than 6,000 deg. F. The adjusting of the flame is important, as an excess of oxygen will oxidize or burn the metal, whereas an excess of acetylene will carburize it. The pressure must not be so high as to cause the blue cone to leave the torch tip or so low that the torch will pop when welding. A larger tip is better than an increase of pressure when more heat is needed, as the high pressure will blow the molten metal over and cause cold shuts. Use a tip large enough to maintain a pool of metal of a diameter about equal to the thickness of the piece that is being welded. Keep the molten metal covered with the flame as much as possible to prevent oxidation, and when finishing the weld, let the envelope of flame cover the pool until the metal solidifies.

So far the work seems easy, does it not? In a subsequent article the use of flux, expansion and contraction, and cutting will be considered.

[The author has made it known that he will be glad to answer any inquiries on welding, as he is always glad to be of any assistance possible to a brother engineer, and would appreciate comments on the article. So send them in to *Power* and they will be published or sent to Mr. Cowles for personal attention.—EDITOR.]

America's Largest Four-Stroke-Cycle Diesel Ends Tests

THE long gruelling test on the first of the 2,700-hp. four-stroke-cycle single-acting Diesels built by the McIntosh & Seymour Corp. for the Shipping Board was finished on March 29. The second engine, which is shown at the left end in Fig. 1, has been completed and is undergoing a similar test. Much interest centers in these two units since they are the largest four-stroke-cycle engines built in this country.

The engines follow the general lines of the corporation's standard crosshead type engines. The cylinders are supported on vertical cast-iron frames which in turn rest upon the bedplate. Between the crankcase and the cylinder is interposed a box casting which seals the crankcase against contamination by fuel-oil drippings or water leakages. The camshaft running along the frame at a level with the cylinder bases is driven from the crankshaft by a spur-gear train. The valves are operated by a system of rockers and push rods. To reverse, these push rods are withdrawn from contact with the cams by the action of an eccentric operated shaft. The reverse control gear then shifts the camshaft longitudinally until the proper cams are under their respective valve-rod rollers.

Air is used on all the cylinders for starting, and as soon as the engine is in motion under the influence of the starting air, all the fuel valves are thrown into action.

The piston is of the crosshead type, and the cooling water is conducted into it through telescopic tubes. The tube joints are placed above the crankcase top, and any leakage is conducted away through drip lines.

SEPARATE UNIT SUPPLIES AIR AND DRIVES ELECTRIC GENERATOR

The main engine has no built-in air compressor, and a 400-hp. auxiliary 4-cylinder unit is used for this purpose as well as to supply the electricity needs of the ship. This unit, as shown in Fig. 2, follows the standard box-frame designs used on stationary engines.

In addition there is a 108-hp. unit direct-connected to a 75-kw. generator and provided with a 310-cu.ft. compressor, so that in the event of a failure of the compressor engine, air can be obtained from this small unit.

The whole engine, together with its auxiliary, was run at full load for 30 days, after which a 10 per cent overload was carried for 6 hours, immediately followed by a 4-hour run at 3,100 hp. The power output was measured by a calibrated water brake, and as a consequence there can be no question as to the accuracy of the load and fuel consumption.

The combined fuel consumption of the main and auxiliary engines worked out as being 0.409 lb. per brake horsepower-hour delivered at the shaft of the 2,700-hp. unit. This is exceedingly low inasmuch as the frictional losses of the auxiliary should be considerably greater than the friction developed in the air-compressor cylinders if they had been direct connected to the main engine. In addition, the fuel used at least during part of the test was very heavy and had a sulphur content of 4.8 per cent. So decided was the sulphur that the exhaust had a most unpleasant odor.

Combustion necessarily, in view of the fuel economy, had to be good, and the clear exhaust indicated that nothing was left to be desired.

The principal dimensions of the units are given in the tabulation.

	Main Engine	Independent Air Comp. Unit	Aux. Comp. Gen. Set
Brake horsepower	2,700	400	108
Speed, r.p.m.	95	200	275
Bore of cylinder, in.	32	217	13⅜
Stroke, in.	60	24	
Weight, lb.	800,000		
Size of generators		75	75
Displacement of air compressors, cu.ft. per min.		936	310
Floor space required, ft	40x11½		
Diam. of crankshaft, in.	21		
Length of crankshaft, ft.	40		
Total height (approx.), ft	32		
Total length, ft.	40		
Total width, ft.	11½		
Diam. of exhaust valve, in.	10⅜		
Diam. of inlet valve, in.	16⅜		
Weight of largest casting, lb.	65,000		
Cooling water per hr., gal.	11,000		
Fuel consumption, main engine and independent compressor unit combined, per b. hp.-hr., lb.	0.409		

It is expected that the two units will be installed on the "West Honaker" and the "West Cusseta."

Two double-acting engines ordered by the Shipping Board are now in the process of construction and will probably be ready for test during the summer.

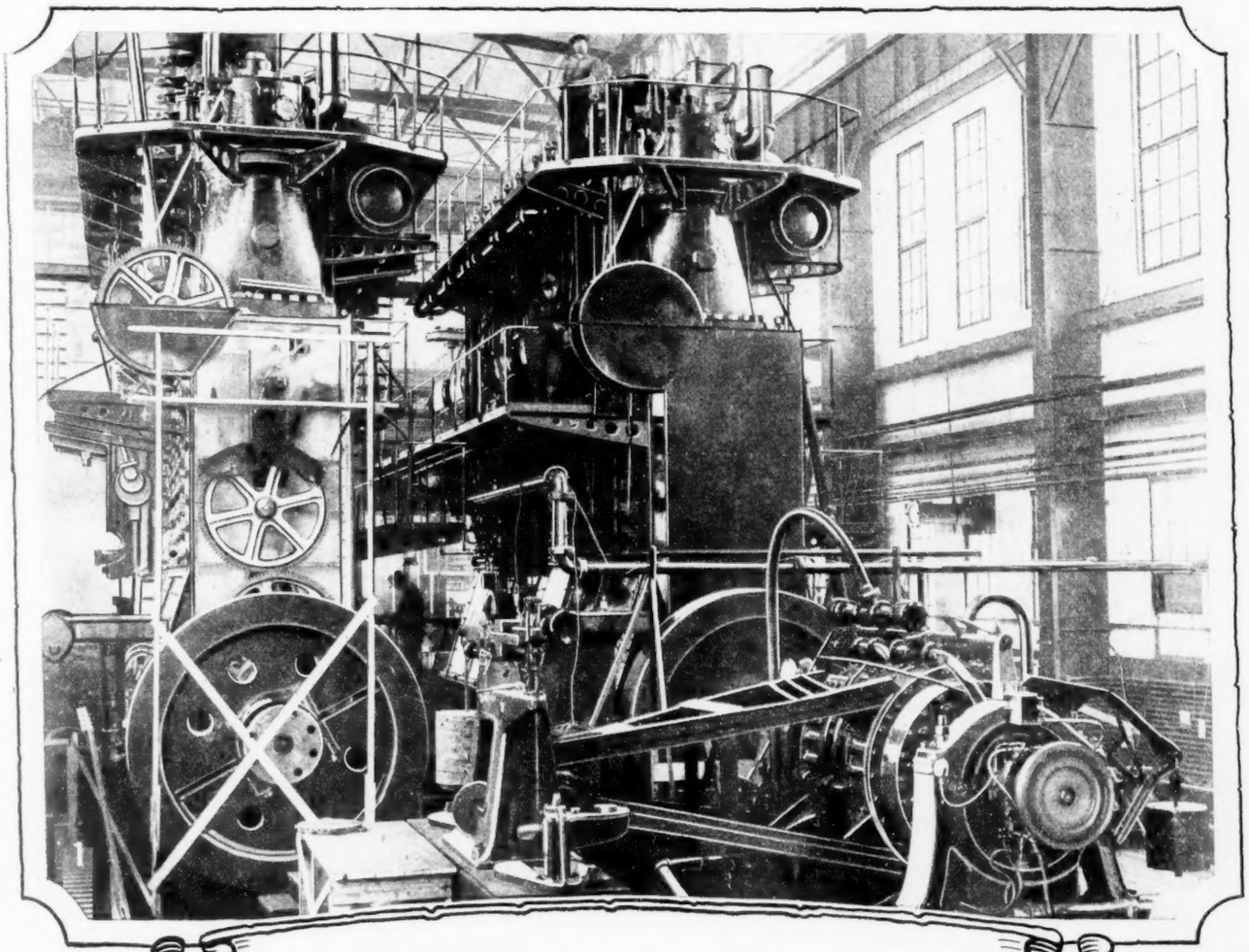
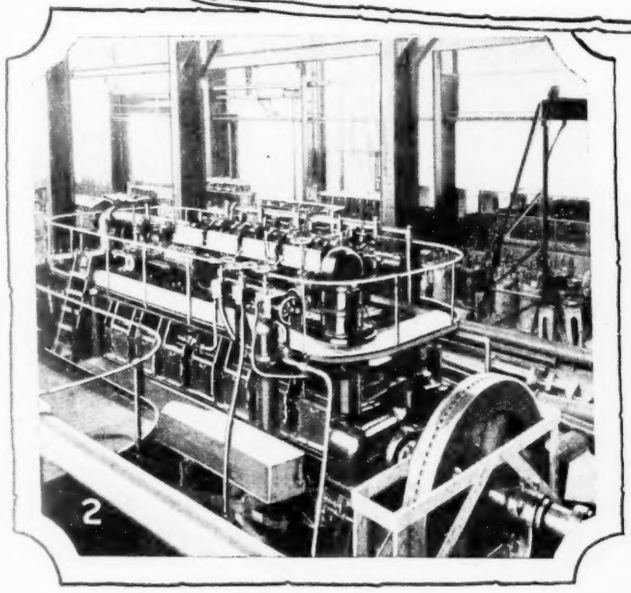
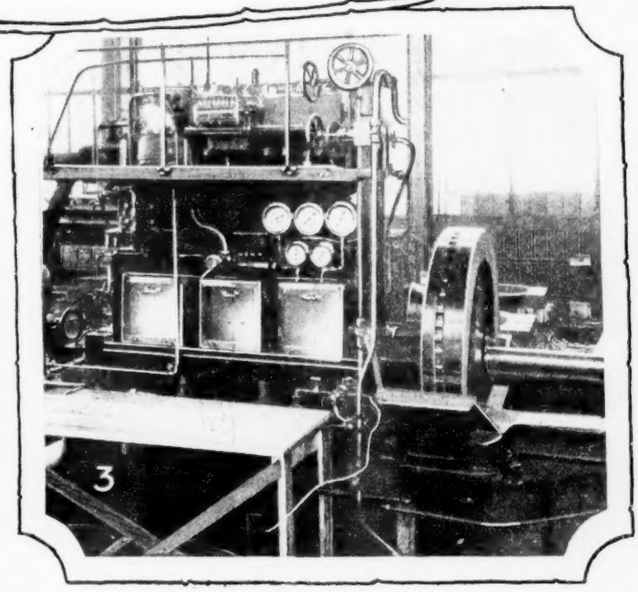


Fig. 1—Two 2,700-hp. four-stroke-cycle Diesels for the Shipping Board

Fig. 2—A 400-hp. Diesel supplies the injection air for the main unit

Fig. 3—Small unit to be used in case of breakdown of auxiliary engine





A Spring Supported Turbine Foundation

By L. J. Rehberg and J. R. James
The Detroit Edison Co.

A somewhat unusual solution of the foundation problem was recently worked out at Marysville power plant of The Detroit Edison Co. Supporting a turbo-generator of 2,000-kw. capacity on a spring mattress eliminates building vibrations and gives entirely satisfactory results in operation.

AT THE Marysville plant of The Detroit Edison Co. the main units are, of course, supported on individual independent foundations, the columns of which rest upon the heavy concrete mat underlying the entire building. In the original installation, however, the house turbine set, a 2,000-kw. turbo-generator, was placed upon the turbine room floor, in accordance with the practice of that company whereby any apparatus weighing 75,000 lb. or less is supported directly on the floor steel system. Although this practice has proved satisfactory in most cases, in this particular case the

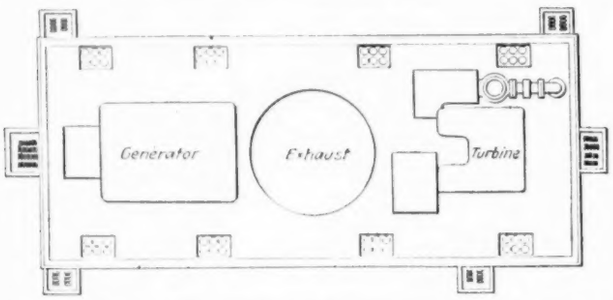


Fig. 1—Eight vertical spring groups carry the weight and six horizontal groups steady the foundation

situation was unfavorable and the results were most unhappy. It chanced that this turbo-generator and a motor-driven boiler feed pump were so located with respect to the steel structure that when both were running exceptionally violent vibrations were set up. At times the disturbance was great enough to interfere with the operation of instruments on the turbine room control board, which was supported on the floor not far from these machines.

When the second house service machine was installed, it was supported on a separate foundation carried down to the underlying mat, and this machine has, of course, operated satisfactorily and produces no noticeable building vibration.

Overhauling of the first house service machine being in order, a study was made looking to the design of an independent foundation, but the arrangement of equipment and piping beneath the floor interposed serious obstacles to such a solution of the problem. The scheme had to be abandoned. At this time it was suggested that a spring-supported foundation be tried.

The foundation, as finally designed, consists of a concrete slab 2 ft. thick, reinforced by a heavy steel framework, supported by eight sets of six springs each, and steadied by six groups of horizontal springs. The machine weighs approximately 30 tons, and the mat about 24 tons. The forty-eight supporting springs (Standard Master Car Builders springs of 7,440-lb. capacity each) were checked by a testing machine and sorted so that all the springs in one group had substantially the same characteristics.

The spring groups are supported by heavy steel framed into the building structure. Each group of springs is backed up by a jackscrew for purposes of

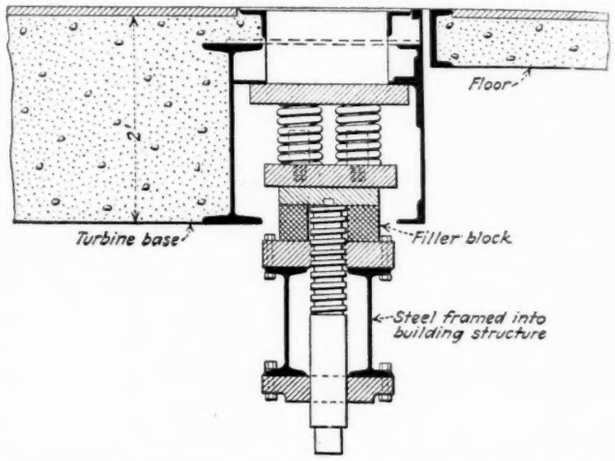


Fig. 2—The vertical springs, six in a group, are mounted on jackscrews, and a filler piece is fitted after adjustments are complete

adjustment to bring the machine to the desired height to level it accurately. The screws are designed so that the space between the nut and the spring box is about 4 in.

The proper position of each spring group having been determined by screw adjustment, this interval was measured accurately with inside micrometers, and U-shaped blocks were machined to this precise dimension and inserted under the spring boxes, so that when the adjusting screws were slacked off and the spring plates rested on solid metal, the base was level and its top was flush with the surrounding floor.

All piping connections to the turbine were, of course,

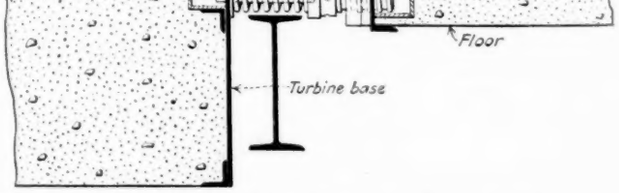


Fig. 3—The horizontal springs also have jackscrews behind them

made flexible and were supported by spring hangers. Flexibility of the main and extraction steam lines was secured by the use of bends, and a copper expansion joint serves the same purpose in the exhaust connection.

The unit has been running for several months, and the foundation has proved entirely satisfactory. The springs prevent the transmission of vibration to the building steel, and the behavior of the unit is much the same as that of the identical unit standing on an independent foundation. The cost of this spring-supported foundation was practically the same as that of the independent foundation supporting the other unit.

Vibration

VIBRATION set up by high-speed, rotating machinery, whether it be a turbine or motor-driven unit, is often seriously objectionable, not only in office buildings but in factories and power plants. In many cases the elimination of this vibration, through the use of independent foundations, is altogether impracticable, and this increases the interest of the solution described on another page of this issue.

A word of caution is in order. Perhaps the oft-repeated tale of breaking down a bridge by playing a suitable note on a violin is a bit overdrawn, but there is no doubt that the natural vibration of any rotating machine, however well balanced, will set up severe vibrations in any system of spring-supported masses the natural period of which is close to the running speed of the machine.

Accordingly, those who desire to apply this method of reducing vibration must proceed with care. Fortunately, it is not difficult to calculate the natural vibration period of a mass supported by springs of known characteristics, and if this period is kept remote from the running speed of the machine supported, there should be no difficulty.

Engineers as Executives

JUDGED by the large attendance of young engineers at the recent New York meeting of the Founder Societies, which discussed "Qualifying for Executive Positions," one would infer that this, rather than the strictly technical lines, is the ultimate goal of the average American engineer. Here is perhaps a point of marked contrast between foreign and American engineers. If some of those who attended the meeting expected to be given a specific recipe by which such a goal could be attained, they were doomed to disappointment. Nevertheless, the meeting was productive of sound thinking and many excellent suggestions, as reported in last week's issue.

Qualities that enable one to forge to the top are largely inherent in the individual; but, as was pointed out at the meeting, training has much to do with bringing out these qualities or permitting them to remain dormant. The speakers were unanimous in urging a thorough grounding in fundamentals in the college courses as most essential in assisting an executive to make decisions along engineering as well as economic lines. One who lacks such training, however well qualified in other respects, is at a decided disadvantage.

The difficulty with the average individual is that he is too close to the picture to make a proper self-analysis. Those who are able to do so may well profit by the specifications outlined at the meeting.

Barring those holding executive positions through financial control or by inheritance, it would appear that there are proportionately as many engineers in such positions as there are men from other professions, in spite of a general impression to the contrary. Obviously, all engineers cannot be executives; some are not temperamentally fitted and others are better qualified to apply their talents to problems of research or design; and, admittedly, circumstances sometimes bar those eminently fitted for the higher positions. But it is well that those so inclined and possessing the inherent qualities of leadership, sustained energy and vision should cultivate all the other essentials so that when the opportunity does come they will not be passed over because of some deficiency.

Where Fuel Costs Nothing

THERE are cases in certain industries and under certain conditions where unsalable byproduct or "waste" fuel is available without cost and in excess of all local requirements. This condition is found, for example, in certain "merchant" blast-furnace plants producing pig iron for the trade. The power requirements being much smaller than in the case of a blast furnace with rolling mill attached, the blast-furnace gas produced is generally more than is needed to operate blowing engines and meet all other power requirements of the plant. A similar condition is occasionally met with in other industries. If arrangements cannot be made to sell excess power to local public utilities or to nearby manufacturing plants, the question of fuel economy in the power plant ceases to be important.

Engineers are so used to thinking of fuel economy as the chief reason for the many refinements of plant design that they may easily underestimate the opportunities for the application of engineering skill in the design and operation of a power plant burning nothing but waste fuel. Yet further consideration will show that many refinements ordinarily justified from the fuel-saving viewpoint alone will pay in such a plant.

Take first the matter of prime-mover economy. While one would not be justified in going as far here as in the case of a plant burning expensive fuel, it is evident that the choice of a prime mover with a low steam rate decreases the required boiler capacity and hence the cost of boilers, furnaces, feed pumps, heaters, water softeners, etc.

The same applies to the electrification of auxiliaries and the use of bled steam for heating. While these will not show a saving as high as in central-station practice, and may in some cases show no net saving at all, it is clear that they all tend to reduce the demands on the boiler room and to that extent affect the first cost.

The fuel saving from correctly designed furnaces and complete combustion with a minimum of excess air may be of no consequence, yet these may make it possible to

operate the boilers at higher ratings. Here again there is a saving in boiler cost which, however, does not extend to boiler-house auxiliaries in this case. In the same way soot blowers, water softeners, flue-gas thermometers, etc., increase capacity as well as efficiency and permit the use of small boilers.

Water softening has an additional justification in increased reliability, reduced outages and reduced repair costs. Feed-water heaters are justified not only by the relief they give the boilers from cold-water strains, but by the fact that they replace a certain amount of boiler and furnace capacity at a lower cost.

So it is clear that on the basis of first cost alone many refinements may be warranted in such a plant. Reliability of operation will still further justify close attention to engineering details.

Finally, it must be remembered that when the supply of waste fuel is insufficient, so that it must be supplemented during certain periods, any improvement in over-all plant efficiency saves as much in fuel cost during such periods as if all of it were purchased.

Do You Select Motors by Guess or by Exact Knowledge?

EVEN though there is a great deal of guesswork in the application and operation of electrical motors, there is an ever-increasing demand for more exact information on selecting the proper sizes of motors for a given load and also for locating defects and possible failures during operation. Such information can be had only by a careful study of the machine while in service. Estimates of the size of motor required, or even sizes determined by short time tests, may not tell the whole story regarding the conditions under which the motor will operate. These facts are obtained by studies of loading and temperatures over periods that allow for all factors that enter into the problem to come into effect, such as changes in ambient temperatures, conditions of ventilation, the mechanical conditions of the driven machine, the product produced, etc.

A motor when first installed has clean surfaces on the coils and core and will radiate the heat generated in its windings and core readily. If the machine happens to be installed in a dusty and dirty place, unless care is taken to keep the motor clean, the ventilating ducts become filled with dirt and the temperature increases. The location of the motor and the surrounding temperature have a marked influence on the load that it can drive continuously, without reaching a dangerous temperature.

With many machines the load will increase after they have been in service for a time, if they are not properly maintained. A good example of these are conveyors. Although they may be in a condition that requires considerable more power to drive them than normal, they give no outward indications that anything is wrong and may operate this way a long time, and all the while the power consumption is increasing. A periodic check on the power consumption will not only show the condition of the equipment, but will give valuable data as to the power requirements of such installations. Furthermore, the saving in power that can be made by knowing the conditions of the equipment will pay a good return on the investment in the meters to determine the electrical load.

Where careful records are kept of motor loads and temperatures, it often offers opportunities of rearrangement of the drives to obtain a better loading of the motors, with higher efficiency and also power factor if of the alternating-current type.

Instead of waiting for an insulation failure to occur and having the motor out of commission at an inopportune time, in many plants periodic tests are made on the insulation resistance of the machine, and when this is found to be getting down to the danger point, steps are taken to find and remove the difficulty at a time that will not cause any serious interruption to production. A defect that is located and repaired before it has developed into a failure may be removed at far less cost than after a breakdown has occurred. Moisture in insulation may cause a failure that will require a complete new winding, but if this is detected before the failure occurs, the defect can be removed by baking and giving the defective parts a coat of insulation varnish, at only a small fraction of the cost of a new winding. The opportunities for using a good set of portable electrical instruments about a power station or industrial plant are many and if intelligently used will prove to be one of the best investments in the plant.

Accounting for Engineers

A FEW years ago a prominent British engineer, visiting this country, gave an address on the education of engineers, in which he stated that the greatest deficiency of most engineers of his acquaintance was their utter inability to keep a simple set of books or to analyze a balance sheet. His criticism could be applied equally well to American engineers. Yet all who advance to positions of importance in engineering or business life, sooner or later are confronted with accounting problems either in the keeping of a set of books or in caring for money set aside in depreciation, obsolescence and other allowances included in the fixed charges. Those engineers, who at some time have to take up valuation, appraisal or rate-making, will find themselves seriously handicapped without some knowledge of accounting. A knowledge of accounting would therefore prove a valuable asset to any engineer and would assist him in keeping other records than those dealing with money accounts.

How many young engineers acquire this necessary knowledge of accounts and accounting methods? One is told that the engineering curricula of colleges are already crowded with too many subjects. Only in exceptional cases can these courses be taken in college. It might be possible for a student to learn accounting in an office by working there during vacations, but generally other activities have more appeal and he may have to do summer shop work.

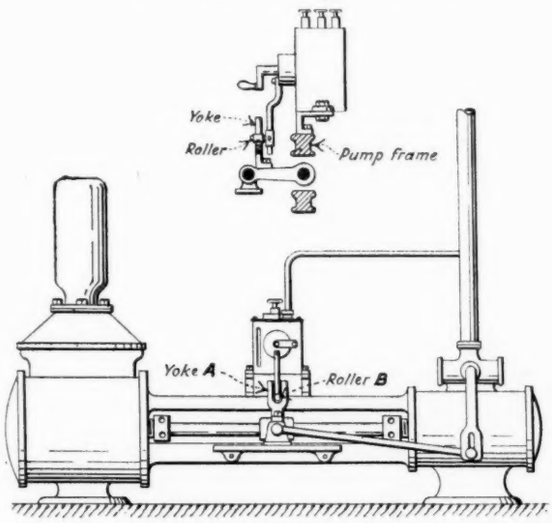
There are opportunities at business colleges and at night schools in almost all large and medium-sized cities for a young engineer to learn something about accounting after he has left college. During the first year or two after graduation, the young engineer is in training and generally has his evenings to himself. This is his opportunity to study some of those business subjects that he needs to know about and for which there was no time in college. Young men completing their college work this summer can well give consideration to such study courses next fall. They will be amply repaid in years to come for the extra effort they may exert in acquiring a working knowledge of accounting.

Practical Ideas From Practical Men

Connecting Force-Feed Lubricators on Short-Stroke Pumps

In the process of installing force-feed lubricators on pumps having strokes 8 in. or less and where limited space precludes the use of rods, the method shown herewith of connecting the ratchet-driving mechanism will be found advantageous.

A yoke *A* is fastened to the casting at the center of the piston rod with capscrews and doweled to prevent



End of pump-driving arm slides in a slot in yoke fastened to piston rod

side play. An old roller *B* from the valve cam of a Corliss engine is connected to the end of the driving arm of the lubricator and made to work freely in the U-slot of the yoke.

This arrangement gives the driving arm of the lubricator an arc of motion anywhere between 30 and 60 deg., satisfying the manufacturer's requirements for good results, also decreasing the wear inherent in the rod-actuating method.

E. A. BAERER.

Jersey City, N. J.

Offending Boiler Spotted With Pail of Water and a Thermometer

It came to pass that the recording steam temperature thermometer was making continual dips, the steam traps were blowing every minute or so and the mill foremen were howling about the steam. We knew we had water in the steam, but could not tell which of the four boilers on the line was dumping the water into the line. The load was heavy and all the water columns behaved very much alike. There were no wells or taps in the individual boiler lines from which to test the steam. So we hit upon the following rather crude but efficacious method of locating the trouble:

Each boiler had an indicating flowmeter on the superheated steam line to the header, and each (half inch) meter line had a union about 3 ft. below the wells, on both high- and low-pressure lines.

We filled a bucket with a weighed amount of cold water and took its temperature. Then we shut off the meter lines and broke the union on the high-pressure or upstream side, blowing out the line well to get it hot and dry. We next put the bucket under the open end of the line and opened the valve, allowing steam to be condensed in the cold water. The water was stirred constantly, while reading the temperature at frequent intervals. Care was taken to lose no water by splashing or too hard blowing of the steam.

When the bucket was almost full and fairly warm, we shut off the steam, stirred the water and obtained the maximum temperature. The bucket of water was then weighed to determine the amount of steam condensed. From these data we figured the desired quality or superheat of the steam. The offending boiler was No. 2, and it figured out as follows:

Weight of bucket plus cold water, lb	26.9
Weight of bucket alone, lb	5.0
Weight of cold water used, lb	21.9
Temperature of cold water, deg. C	7.1
Temperature of final mixture of steam and water, deg. C	73.3
Rise in temperature of water due to steam deg. C	66.2
Heat absorbed by cold water, (21.9x119.2 deg. F.*) (This is equivalent to the heat given up by the steam)	B.t.u. 2,610
Weight of bucket plus hot water, lb	29.5
Weight of bucket plus cold water, lb	26.9
Weight of steam condensed, lb	2.6
Heat given up per pound of steam (2,610 ÷ 2.6) B.t.u.	1,001
Plus 2 per cent for heat losses, B.t.u.	20
Plus 164 — 32, (73.3 deg. C = 164 deg. F.) B.t.u.	132
Total heat in steam above 32 deg. F., B.t.u. per lb	1,153

The steam pressure in the line was 185 lb. gage, or 200 lb. absolute. For this pressure and a total heat of 1,153 B.t.u., the Mollier diagram gave a quality of 94.7 per cent, or 5.3 per cent moisture.

The three other boilers averaged 100 deg. superheat. The calculations were handled exactly as before, but the total heat in the steam came higher—for instance 1,257 B.t.u. in one case where the absolute pressure was 200 lb. Reference to the Mollier diagram or to the superheated steam tables shows this to be equivalent to a superheat of 100 deg. F., or a steam temperature of 482 deg.

Of course, there were many sources of error: The "sampling" tube was flush with the inside of the pipe instead of extending diametrically across the line with perforations; the delivery pipe was uninsulated, as was the bucket; some water may have splashed out in carrying it back and forth to the scales—and so on. We estimated these errors as 2 per cent and let it go at that.

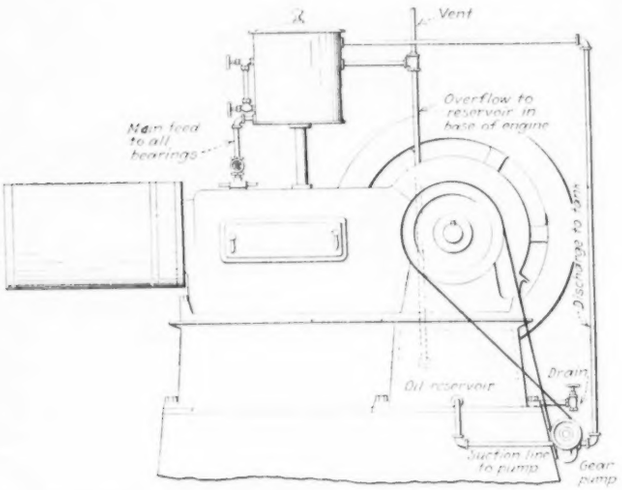
L. G. JONES.

Pittsburgh, Pa.

*One centigrade degree equals 1.8 Fahrenheit degree, so 66.2 deg. C. = 66.2 × 1.8 = 119.2 deg. F.

Installing Automatic Oiling System on Small Horizontal Engines

In a textile mill power house, the engines that drive the stokers and forced-draft fans were oiled by a gravity system from a small tank above the engine frame. The engines, of which there are four, are of the inclosed type, and the oil when drained to the oil reservoir in the engine base was taken out and put into the tank again. As this called for considerable attention, it



Small gear pump discharges oil from engine base to gravity tanks of oiling system

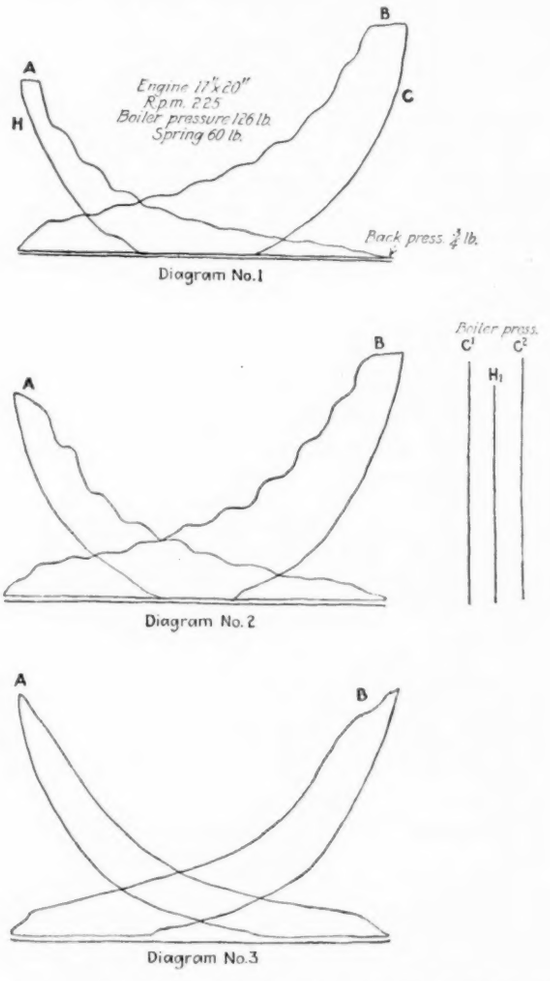
was decided to make the operation of the oiling system automatic. Small geared oil pumps were purchased and were driven by a belt from a pulley on the engine shaft. These pumps were fitted with a $\frac{3}{8}$-in. suction and discharge opening. A new tank was installed with a capacity of about 4 gal. An overflow pipe (with a vent extending up above top of tank) runs to the reservoir in the engine base to keep the pump supplied with oil at all times. A sight feed glass shows the height of the oil in the tank. This outfit has given good results and was installed at a small cost. It could be connected up with a filter, but in our case the oil is taken out once a month and filtered and put in again.

Lawrence, Mass. ALVIN D. KANE.

Improperly Set Valves on Uniflow Engine

The indicator diagrams shown were taken from a two-valve 17x20-in. uniflow engine shortly after it had been installed. The engine had not been indicated when erected, and a peculiar irregular exhaust led the engineer to believe the valves were not set properly. On indicating the engine, the diagram No. 1 showed that the engine was not getting full pressure on the head end. The back pressure carried was $\frac{3}{4}$ lb. This condition led to some study as to the cause of the trouble. The engine has a direct-connected valve gear with a shaft governor and the inlet valves were of the poppet type.

Before making any change in the valve, the engineer decided to check up on all the adjustments from the eccentric back, and took diagram No. 2 in order that he might also check up on the indicator. The diagrams were much the same, except for a longer cutoff due to the increased load and a more wavy expansion line. The vertical lines C′, C² and H′ were taken after the diagrams to see if the indicator piston was sticking. These lines correspond to the height of the different steam lines on the separate diagrams. It was found that the indicator pipe connecting the two ends of the cylinder leaked at the threads considerably, which might account for the wavy expansion line in the diagrams Nos. 1 and 2. So the eccentric strap was gone over, but it was not loose enough to permit removal of any of the shims. The eccentric rod connection to the rocker arm was quite loose and a shim was removed. The valve rod on the other end of the rocker shaft was examined and a thinner shim put in; the ball-and-socket connections



Indicator diagrams taken when adjusting valve gear

to the sliding bars over the valves were also adjusted. On this type of engine, removing or adding shims to the brasses of the eccentric rod or valve rod may make considerable change in the operation of the steam valves. After this work had been done, diagram No. 3 was taken, with about the same load and 130-lb. boiler pressure. This diagram showed a big improvement in the operation of the head-end valve. There is still a slight difference in the height of the steam lines which may be corrected by screwing the valve stem down farther into the poppet valve, and there is less movement to the governor and a more even exhaust at the exhaust head.

R. A. CULTRA.

Cambridge, Mass.

Comments from Readers

Exhaust Versus Live Steam

Concerning J. G. Smedley's discussion in *Power*, March 16, I have in mind a factory using hot-water heat where events apparently bear out the claim that exhaust steam is more efficient than live steam for heating. In daytime we operate a 300-kw. unit and one water-tube boiler. At night the watchman had to have two boilers in service to keep the buildings from freezing up, and the hot water was 2 degrees lower in temperature than when the engine was in service exhausting into the hot-water tank. I had them run a 75-kw. unit on the throttle to supply the lights required by the watchman and the outside lights. We then got a higher temperature and were able to run with one boiler.

Chicago, Ill. FRANK ENGELHARDT.

An Engineer's Lot Could Be Worse

In regard to Carl F. Miller's plaint in *Power*, March 23, as to the tough time he had in the power-plant game, I am not going to admit that an engineer's pay does not compare favorably with that of other workmen, aside from building tradesmen. If it appears otherwise, this is due to partly psychological reasons, for although the engineer's hour rate does not equal the other fellow's, the employer notes that the engineer's pay envelope compares favorably with those of the other workmen. The fact that the power-plant man has greater responsibility and works more hours does not make much impression on him.

Another thing that makes the employer more inclined to ride hard on the power man, especially in industrial plants, is the fact that his labor is charged to expense, not production, and such labor does not look good to any manager, no matter how broadminded he is or how much he realizes its necessity.

The real engineer loves his work, likes responsibility, enjoys doing things that give play to his creative and inventive talents. An engineer must be of a combative turn so far as his work is concerned, otherwise he would lose heart and be a failure at his chosen work. If he does not feel this way, he is probably misplaced.

We cannot live on love, so all, high and low, take a lively interest in the pay check. I was always more interested in the size of my weekly pay envelope and yearly income than I was in the amount of hard scrapping it took to get it.

The brick mason gets $1.50 an hour, but how does his yearly income compare with that of the engineer? The machinist gets more cents an hour, perhaps, but how large is his yearly income? I know nothing about wage rates in other localities than this, but I am going to be so reckless as to say that I believe the engineer is holding his own with the other fellow in the money he is able to tear away from his employer.

As to rank, I believe the engineer will in most cases be found ranking at least as high as department heads. In many cases he stands higher than this, in that he is capable of advising and is consulted on many things not connected with the power plant. I believe the engineer who has the confidence of his employer has more privileges and liberty of action than department heads usually have.

I am rather of the opinion that Mr. Miller made a mistake the first few years he was in the plant. He should have made a thorough analysis of his employer and the prospect for advancement and if these did not look good, go gunning for something better; this is one of the most essential things for a young man to do.

Anderson, Ind. J. O. BENEFIEL.

The Lecture Fetish

The comments of J. A. Dent in *Power*, March 23, on an editorial dealing with "The Lecture Fetish," are not a direct reply to the objections raised in the editorial, and he ignored a very practical method of supplementing the textbook by mimeographed sheets.

Although no text book may represent exactly the lecturer's views of how the subject should be handled, some of them afford fairly complete presentation of the elements, so that a prepared outline relating the text to the lecturer's ideas by relieving the student of the necessity of taking notes allows the lecturer to go ahead faster and enlarge on the recent developments and related subjects, or to devote part of the time to a combination of lecture and recitation in which the students may ask relevant questions. These are often more effective in clearing up uncertainties in the minds of the students than a much greater amount of formal lecture covering a wider survey of the subject.

There is in any subject a large amount of fundamental facts that must be memorized as basic working equipment, and this can most easily be done from text books, but the most valuable part of a university education is to understand how to use them and the relation of those facts taught in one course to those taught in another, which is where the instructor comes in.

Of course, to handle informal discussion of this sort successfully where the questions are likely to lap over into the borderland between the courses as taught, requires an instructor of more experience than the last year's graduate who has returned to teach, but with capable instructors courses taught in this way are the most interesting and valuable in the curriculum.

Engineering education is not the only one that seems to be suffering from short-cut, ready-made substitutes for study, as I notice even in the primary and grammar schools a tendency to overemphasize the lectures and preparation of notebooks and to rate the standing almost altogether on this basis. The logical sequence is the educational moving picture, which has a certain following, but, as in other fields, the old saying, "Easy come, easy go," holds and it will probably be a long time before anyone discovers a system for fixing facts in the memory like having to work hard over them.

New Haven, Conn. H. D. FISHER.

Convenient Engineering Units

In *Power*, April 6, George S. Billman objects to the use of the letter *K* for designating 1,000 B.t.u. on the ground that this letter is particularly associated with electrical units. With such terms as *kilometer* and *kilogram* in common use, it seems to me that his claim is not well taken. It is true that the syllable *kilo* is more extensively used in the metric system of units than in other systems and that the use of this system in this country is largely confined to electrical applications. However, many of the units are purely mechanical, and in other countries are commonly so used.

The suggestion that we designate 1,000 B.t.u. by the symbol *TM* is open to the objection that such a designation does not give the large unit a name. The use of *M* for 1,000, as I have already pointed out, is open to the objection that it is desirable to reserve this letter to abbreviate the syllable *mega* to designate one million. Inasmuch as *K* is available for 1,000, it seems better to use it for this quantity. JAMES A. HARRIS.

New York City.

Asbestos Better than Clay in Babbitting

In the March 30 issue, in discussing journals, E. Darwell stated that putty was preferable to clay for the bearing ends, as moisture in clay tends to cause sputtering and may injure the workman. I agree with him for I have been through it all.

About 15 years ago there appeared a short item in *Power* which advised making lute for babbitting by mixing ground asbestos and steam cylinder oil. During the past years I have continually used this mixture but have never found anyone else doing so. It will stick to bearings in hot or cold weather, and as it contains no moisture, it cannot blow or sputter. It can be used over and over again, and when the job is finished, can be laid away for a year, and still be as good as ever. In fact, it improves with use as it becomes more thoroughly mixed.

Ground asbestos such as is used for coverings, steam pipes and often boilers, can be obtained from most plumbers and steamfitters. It should be mixed with steam cylinder oil only. Mix it like a batch of bread and knead the dry asbestos into the oil until the material is stiff like putty.

During 25 years of handling of machinery in the construction field, I have had occasion to use many hundreds of pounds of babbitt and I am sure that this mixture, once used, will always be kept on hand thereafter by anyone doing occasional babbitting.

Powell, Wyo. WILLIAM I. MORGAN.

Clearing a Separator Without a Trap

The article on clearing a separator without a trap in the Jan. 26 issue interested me, as I once had a separator on the main steam line to a Corliss engine that drained back into the boiler blowoff pipe, just ahead of the blowoff valves. There were two globe valves and two check valves, one on each branch, as there were two boilers in the battery. Although it gave no trouble, I had it trapped to a receiving tank with an inverted bucket trap, which I think has a tendency to create a scouring effect on the separator, keeping it clean and clear.

We generally shut off the 5-in. auxiliary valve that furnished the shop with steam, on Sunday morning in the summer time. After the night crew stopped work on one Sunday morning, a kier was boiling, unknown to the night engineer, and when the steam valve was closed and the pressure dropped, the steam condensed in the main line, forming a partial vacuum. The pressure in the kier forced the caustic solution into the main line, which was trapped and drained through the return line to the vacuum pump. On Monday morning, when the vacuum pump was started and the steam turned on, practically the entire contents of the kier were pumped into a receiving tank used to feed the boiler feed pump and thence into the boiler. One can imagine the action of the water in the boiler after the engine was started. The water started foaming and priming, and about a glass of water went over to the engine, shutting it down, but causing no damage.

The boiler was cut out and another one started; no return water was used during the rest of the day.

I doubt if any separator could have taken care of the quantity of water that went over to the engine that morning. W. R. MAYNAN.

North Dighton, Mass.

Why Boiler Tubes Burn Out

I read with interest the article, "Why Boiler Tubes Burn Out," by George C. Reinhard, in the Jan. 12 issue. The conclusion drawn throws considerable light on a subject that warrants more extended discussion and on which I would like to record my own experience.

There is one conclusion drawn by the author of the article which should be further investigated before coming to a definite decision as to what causes tube failure in oil-fired boilers. He stated that this failure occurs due to the burning away of the tube from the outside, this burning away occurring first, followed by the formation of a slight bulge where the tube was weakened. Just how this was proved by a superficial examination, he failed to say. The fact that the bulge is localized, is certainly no evidence on which to decide that it did not occur until after the tube had burned away, any more than to assume that there was no strain on a chain except in the link that broke. Neither is it true that when a bulge is caused by scale, it is due to the fact that the iron is separated from the scale by a steam cushion. If steam were next to the iron, it would keep the iron cool and prevent overheating. What really occurs is, the scale adheres to the iron and keeps the steam and water away from it, with the result that the tube burns out owing to the fact that the scale is a poor transmitter of the heat.

The fact that the author found the soot on the tops of the tubes to be thicker than on the bottom was to be expected. That this soot was of a greenish color and soft and moist means nothing. Had he examined the tubes while the furnace was still hot, he would have found this soot to be dry and to be composed of carbon, sulphur and iron, the iron being due to rust on the tubes.

The equations, as worked out by the author, are correct, but these chemical reactions do not take place in a boiler furnace, as the temperature is such that nothing but gases are present. Further, if failure was due to sulphuric acid attacking the tubes from the outside, why is it that it is the bottom rows of tubes that give trouble, and this trouble in the first pass only?

The acid reaction ought to be stronger on the upper rows of tubes where the temperature is lower and the opportunity for moisture to form is greater than in

the hotter part of the furnace. If the remedy for this trouble is the elimination of the sulphur in the oil, as stated by the author, why is it that as much trouble is experienced with tube failure when burning California fuel oil containing 0.5 per cent sulphur, as when burning Mexican crude oil containing from 2½ to 3 per cent sulphur?

The writer is of the opinion that the cause of tube failure is from the inside of the tube. This opinion is based on observations made in three oil-fired plants, having boiler-heating surfaces ranging from 50,000 to over 200,000 sq.ft. One of these plants is on the Pacific Coast and burns California oil; two are on the Atlantic Seaboard and burn Mexican crude oil. The observations extend over a long period of years.

These plants are equipped with three-drum, inclined-tube water-tube boilers. All have been troubled with tube failure. It was observed that the tubes invariably failed under the same one of the three drums. Upon analyzing the water from the drum on which tube failure occurred, it was found that this water was more highly concentrated than in the other two drums. This statement applies to every boiler in all the plants. It is on this condition that I base the statement that the cause of failure is internal and not external.

The tube failure is invariably on the bottom row of tubes. In some cases a tube lets go, making it necessary to shut down the boiler. Upon examination it might be found that several of the tubes require renewing or driving up. The bulges in some cases are bulbs or swellings of the tube the size of a half dollar, the thickness of the metal through the bulb being nearly that of the original tube and showing no sign of external burning. In other cases the tube has wasted away on the outside, this wasting away being due to the fact that the boiler has been operated for some time after the bulb or forcing out of the metal has occurred. I ascribe this to formation of scale on the inside of the tube; this causes overheating of the tube and the pressure on the inside forces the metal out, followed by the oxidation and burning away of this metal.

Oil in the boiler-feed water, as every operating engineer knows, will cause tube burnouts and bagging of the shell on return-tubular boilers. The oil under the action of heat settles to the bottom of the tubes or shell and forms an insulation medium many times more effective than scale, causing overheating and failure of the metal. The purer the feed water, the more disastrous is a small amount of oil, as it then adheres directly to the iron. Oil alone, however, does not account for these tubes failing, for one of the three plants in question is a central station with turbines as prime movers, with no oil getting into the boiler feed water. The other two plants are industrial plants, one with turbine drive and the other with reciprocating engine drive. Two of the plants have rear-shot steam-atomized burners, the other front-shot mechanical-atomized burners. Considering that the plants mentioned, located in different parts of the country, operated under different conditions and with different fuel oils, had tube failure under those drums having the highest concentration of feed water, it seems logical to conclude that the condition of the feed water is the primary cause of tube failure.

Various remedies have been tried to correct this condition. At first an attempt was made to so regulate the feed-water valves on the individual drums that the water in all drums could be kept at the same concentration. This failing, the feed-water piping was changed in an attempt to deliver exactly the same pressure to each drum. This also was unsuccessful. The next attempt was to regulate the blowdown. The water from each drum is tested periodically and the blowdown so regulated that the concentration is kept below a certain point. Regulating the blowdown and turbining the tubes under the drum which has a tendency to show the highest concentration, is a good method of preventing tube burnouts. The most effective method would be to have a pure feed water. Where the feed water is free of scale-forming compounds, no trouble is experienced with tube burnouts on oil-fired boilers when operating at 300 per cent rating.

ALEX. M. ORMOND.

Savannah, Ga.

Opening and Closing Blowoff Valves

I want to correct an answer to a question that appeared in *Power*, March 23. The question was, "In what order should the two valves, or valve and cock, on a boiler blow-off line be operated?" The answer recommended the opening of the valve nearest to the blow-off main, followed by the opening of the valve next to the boiler.

The answer given apparently reflects the common lack of knowledge on this particular point, but it is too serious to go unnoticed. It is a wonder that serious accidents do not occur on account of the way boiler blowoff valves are handled in some plants.

The sole purpose of installing two valves in a boiler blowoff line is one of safety, but this feature can be entirely lost if the valves are not properly used. Both valves should be closed at all times when not blowing down the boiler. To blow down, first open the valve next to the boiler wide, then slowly open the other valve and permit the water to blow out. In closing, first slowly close the valve nearer to the outlet line, and then completely close the valve next to the boiler.

The reason for this procedure is almost self-evident. The wear comes on a valve in opening it under unbalanced pressure, and during the time while it is being opened and closed, as then the area for flow is more or less restricted and the water and sediment are flowing through at high velocity, with a consequent cutting action on the valve and seat. This opening and closing period must be prolonged, on account of the danger of pipes or fittings being bursted by water hammer if the valve is opened or closed quickly. By opening the valve next to the boiler first and closing it last, it is saved all this wear, and when the outside valve becomes worn the inside valve is still in shape to hold the water in the boiler while repairs are made. Some boiler operators make a practice of never closing the valve next the boiler, thinking to save wear on it in this manner and so have it ready for an emergency. Unless the valve has been operated regularly, it will usually be found to be clogged with sediment when it is necessary to use it, so that it is a dangerous practice to leave it open all the time.

If a plug cock is used, it is generally placed next to the boiler, as it will be evident from the foregoing that it should be. This matter of operating blowoff valves is considered so important that one manufacturer has placed on the market a tandem arrangement of blowoff valves that cannot be operated in any other manner than the one here given.

Lafayette, Ind. WILLIAM E. GRAY,
Instructor in Mechanical Engineering,
Purdue University.

Dalton's Law Applied to the Refrigerating System

In *Power*, March 30, there appeared an article by Prof. H. J. MacIntire, entitled "Dispelling Some Ammonia Condenser Fallacies." I wish to point out that Dalton's Law, which was discussed in the article in question, is derived from a consideration of perfect gases and may be safely applied only to the case where non-condensable gases only are present, all vapors being absent.

When a non-condensable gas is in the presence of a condensing vapor, it interferes with the conversion of the vapor into liquid directly, either by polarizing the condensing surface, thus reducing the effective condensing area, or by changing the thermal resistance to heat transfer. Here polarization is used in the sense of the formation of a gas film, either continuous or as bubbles, by which its presence increases the resistance to the flow of heat.

This fact renders negatory all considerations following from a reasoned application of Dalton's Law. Consequently, many not understanding this point, attribute the rise in condenser pressure from, say, 150 lb. corresponding to the existing temperature, to 175 lb., as due to the existence of 25 lb. air pressure. In fact the non-condensable gas, through its interference in the condenser action, causes the corresponding increase in pressure necessary to maintain the necessary heat transfer.

The essential thing to be borne in mind is that the increase in heat pressure due to the fouling of the system by air, is dependent upon the presence of the air and not to its partial pressure.

Chicago, Ill. JOSEPH P. DUNCOMB.

Should the Coal Mining Industry Be Regulated?

I have read with interest the Foreword in the Feb. 23 issue entitled "The Coal Strike," as well as the article in the March 23 issue by George H. Gibson, "Why Regulate the Coal Industry."

Regulation of business enterprises through governmental agencies has gradually grown into a more or less favorite pastime, but we do not seem to accomplish much when we get right down to the question of costs and prices as they affect the consumer.

The net result of regulating business seems to be to make things that are regulated cost more and not less. And as a general thing this regulating of business is badly overdone. In some channels and on rather a flimsy ground from an economic viewpoint, the general public seems to get stuck.

Take the Interstate Commerce Commission for example and its ruling on the application of Henry Ford's railroad—the Detroit, Toledo & Ironton—for permission to reduce its rates. The commission said in effect, "No, you might disturb the railway situation elsewhere," or something along that line. I do not pretend to know anything about this case except what I have read in the papers. This I do know from reading Mr. Ford's own published statements, that he personally owned substantially all the stock and all the bonds of the road. If this be true, I cannot now, nor have I been able before to fathom the logic of refusing him the request to lower his transportation rates. Especially so, since he would take the risk alone.

No widows, orphans, life insurance companies or investment bankers would have suffered if these new rates did not fit. Mr. Ford would have paid, and we might have found out some things about the development of railway earnings through modern ways of doing things.

Ford has cut his factory operating expenses to the minimum and paid higher wages in the bargain. He wanted to cut his transportation rates, but the government regulating body said "No."

Another practical example is in the passenger fares between Milwaukee and Chicago. There are three lines between these cities, two steam roads and one first-class high-speed electric line. The electric-line passenger fare between these cities is $2.57, the steam roads charge $3.06. We have been informed by steam-railroad employees that the Interstate Commerce Commission will not let the steam roads meet the electric-line rate. I am wondering if trolley poles were placed on the top of the steam passenger coaches if it would make any difference in the ruling laid down by the Interstate Commission.

Frankly, I am skeptical about most regulation. There is only one thing about most of this regulation that we question and that is, "It does not work."

I am afraid that if coal is tackled, we may land in the same place, because politics would be first and coal second. This fact, however, stares us squarely in the face—coal is the most important of any of our non-renewable raw materials. We have more coal in this country than any other two or perhaps three nations on earth. Yet if we stop the mining of coal for a few weeks, we put the whole business machinery of the country up in the air and the coal prices along with it. This has grown to be a regular periodic affair and we all pay and kick, nevertheless nothing is done about it.

We have heard a thousand times more about conserving and regulating our National water powers than we have about conserving and regulating our coal. Yet coal reaches and directly affects many times more people than all the water powers of the country will ever reach. It is a well-known fact that much of our developed water power today is sold subject to the prices of coal. We do not know what coal has to do with the volume of water in the Mississippi River or with that which goes over Niagara Falls, but we do know that power from both these sources is sold at prices contingent on the prices of coal in the markets where the power is sold. Unquestionably, coal is by long odds the most important raw material resource we have, and we let it run wild and think nothing of it.

The methods used in fixing the government price of coal during the war would make interesting reading. We made superpower reports under the guise of saving our coal and instituted a fuel administration and advocated water-power development from one end of the country to the other, but little was done to stabilize the coal industry.

Perfectly good coal contracts were repudiated right and left by coal operators for just one purpose, in my opinion, and that was to boost up the price. I have no remedy to offer in particular, but if we would put one-half of the legislative effort and one-quarter the money that has been spent on Muscle Shoals water power, into constructive work with our coal industry, we might accomplish something. EGBERT DOUGLAS.

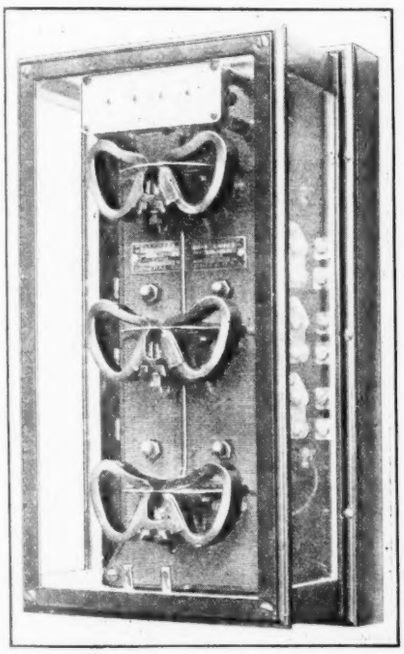
Milwaukee, Wis.

New and Improved Equipment

Three-Element Watt-Hour Meters

A polyphase watt-hour meter, shown in the figure, having three single-phase elements has been introduced by the General Electric Co. Two designs are available, the side-connected, house-pattern, and the back-connected, switchboard-pattern. The three-element type of meter is intended for metering four-wire, three-phase circuits and is recommended where high accuracy is required, particularly where the circuit is unbalanced.

The same fundamental principle used in the two-element type of meter is



Four-wire, three-phase meter

utilized in the three-element types in both service and switchboard forms. The meter is simply lengthened to accommodate another single-phase element, which is attached to the base in the same manner and which is equipped with the same balancing adjustments. The shaft is correspondingly lengthened to care for the additional disc. The new meters embody the same features that characterize the two-element type, and in addition provide the extra element necessary for correctly metering on the three watt-meter principle any four-wire, three-phase circuits. The latter is a method that has been generally used heretofore.

This same construction is often useful for special metering applications as in totalizing two separate circuits, such as a three-wire, two- or three-phase power circuit and a single-phase lighting circuit.

Victaulic Pipe Joint

A new design of pipe joint known as the Victaulic joint, which has been used for some years in foreign countries, is being introduced in this country by the Victaulic Co. of America, 26 Broadway, New York City.

The joint is designed to take the place of the ordinary flanged and screwed couplings, or bell-and-spigot

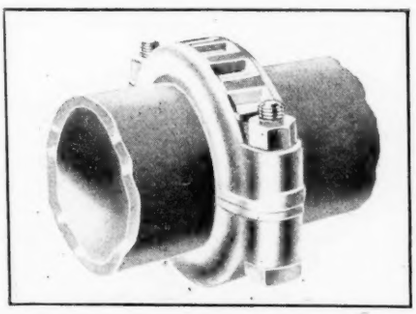


Fig. 1—Assembled Victaulic joint

joints and requires a pipe having either grooved or beaded ends. The joints consist of two half housings *A*, two clamping bolts and a leakproof packing ring *B*. The half housings are machined to fit in the grooves in the ends of the pipe and thus hold the pipes together as well as serving to locate the packing ring over the ends of the pipe. A small clearance is left

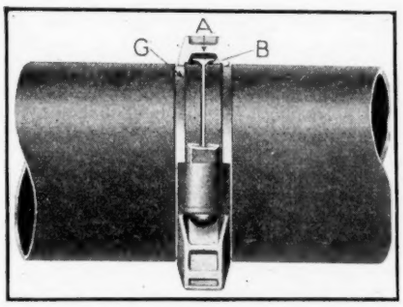


Fig. 2—Cutaway view showing details of construction

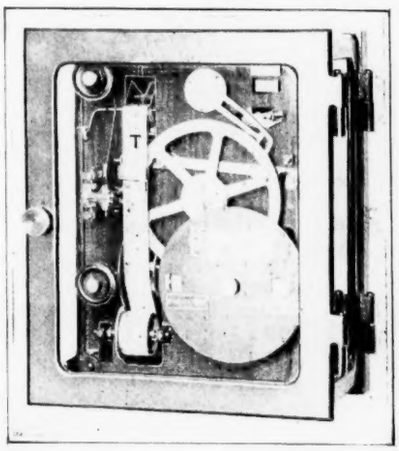
between the ends of the pipe to give flexibility. The packing ring, which is made of a specially prepared rubber, is stretched over the end of the pipe and the half housings bolted together over it. The housings are made of forged steel or malleable iron according to the pressures involved.

Some of the advantages claimed for this type of joint are flexibility, saving in cost of installation, elimination of expansion joints, ease of removing without disturbing abutting pipe, since a section can be removed by a straight horizontal movement. Because of their flexibility, pipe lines using this type of joint are said to have proved successful over rough and uneven ground on lines subject to vibration and lines that frequently have to be moved. The joint may be remade by using the same parts repeatedly. A view of the assembled joint is shown in Fig. 1 and the details of construction in Fig. 2.

Meter Prints Demand for Each Interval

A new demand meter manufactured by the General Electric Co., shown in the figure, differs from previous recording demand meters in that it prints directly the demand for each interval.

With the previous designs it was necessary to subtract consecutive readings in order to obtain the correct demand; in the new meter the printing



Front view of new demand meter

wheels return automatically to zero at the end of each interval.

Figures that represent the demand of any metered circuit are printed on a narrow paper tape, *T*, which is graduated in time so that the record shows the demand and the time of day at which it occurs. A strip of the tape is visible at all times, so that the record for a considerable number of preceding intervals is always in plain view.

Other features of this meter are three extra dials or indices. One shows the maximum demand that the meter has recorded since last manually reset. The second shows the present interval demand—that is, the number beneath the printing platen at that time; and the third dial, or cyclometer, registers the total number of contacts delivered to the demand meter. The latter provides a means of verifying the registration of the demand meter by comparing it with the watt-hour meter register with which it is coupled.

Explosion Hazards from the Use of Pulverized Coal at Industrial Plants*

By L. D. TRACEY

PULVERIZED coal in bulk is not explosive. It becomes dangerous only when stirred up into a cloud with the proper proportion of air and brought in contact with an open flame or with a body having a temperature high enough to ignite it. Fineness is the physical characteristic that governs explosibility. In general, any coal retained on a 20-mesh screen does not enter into the propagation of an explosion.

Furnace Dust Explosive

In the buildings of an industrial plant a rather unsuspected danger lurks in the dust from some types of heating furnaces, which settles on girders, beams, electric cables, switchboards and any other place upon which it can lodge. This condition is characteristic of small furnaces using pulverized coal. Many such furnaces designed to burn natural gas have been altered to use pulverized coal without change in the combustion chamber. Combustion chambers for natural gas are usually too small for the complete combustion of pulverized coal, and minute unburned particles are apparently blown through the combustion chamber into the outer air. Samples of dust taken from an industrial plant show volatile matter ranging from 6 to 24 per cent and fixed carbon from 50 to 67 per cent, the ash content ranging from 22 to 32 per cent of the dust samples. Laboratory tests show that many samples of this dust border very closely on pure coal dust in inflammability and explosibility. It seems obvious that a furnace that more nearly approached perfect combustion of the fuel would be the type to reduce explosion hazards from this cause. The paper shows designs of furnace that it is believed lead to most complete cumbustion.

Causes of Accidents

A number of actual explosive accidents are described fully, due to powdered coal being thrown on open lights, to the lighting of matches in a dusty atmosphere, to the short-circuiting of electric wires by moist coal dust, and to an open salamander stove in a building covered with coal dust. One of these accidents, which burned several men very severely, occurred out of doors, showing that a dust cloud can produce very serious results, even when not confined in a building or other structure.

Many accidents charged to pulverized coal are due largely to ignorance of its characteristics. When plants are properly designed and operated, such fuel is probably no more likely to flash or explode than is natural gas. Natural gas has long been recognized as a deadly menace when uncontrolled near an open furnace, consequently the odor of escaping gas is a danger signal and steps are taken to stop the leak immediately. On the contrary, if a coal transport line or conveyor is leaking pulverized coal, little attention is given to it. Yet a leaking line of coal dust has the same potential danger as a leaking gas line.

Danger in the Drier

The man who runs the drier—the one who actually shovels the coal into the furnace, not the person in general charge—has a responsibility similar to that of the man in charge of a battery of boilers. If he performs his duties improperly and allows the drier to overheat, an explosion is almost sure to follow. Driers should be equipped with bypasses for use when they are not in operation, so that the gases of combustion cannot pass through the drum.

Next to the drier one of the most prolific sources of trouble is the large main used for the circulation of a mixture of coal dust and air in certain systems of distribution. Irregularities in air pressure due to variations in flow may cause secondary air to enter the distribution main, carrying with it hot particles from the furnace.

Oxidation in Storage

Because bituminous coal tends to absorb oxygen rapidly and thereby reach a stage of combustion, the storage of dried or pulverized coal should be limited to as small an amount as possible. A commendable practice is so to regulate the coal supply that no dried coal is in the plant when the furnaces are shut down for more than four hours. The critical point at which oxidation of coal begins to increase rapidly seems to be about 150 deg. F.; from that point the temperature increases rapidly to the ignition point.

Bins should of course be tightly covered and all manholes and other openings should be airtight. It is well to vent bins to the outside air for the release of pressure. This vent should have a valve that can be closed whenever the bin is out of operation and yet contains an appreciable amount of fuel. In this way the liability to spontaneous combustion is decreased. All joints should be welded, and in actual practice it has been found that if the corners are well rounded the coal is less likely to cake and adhere to the sides. It seems wise to remove pulverized-coal storage bins from immediately over furnaces and preferably to construct them outside the main building.

A pulverizing building should be so situated that there is no chance of sparks entering through windows, ventilators or doors. If this is impracticable, all openings should be screened.

Control of Fires

About the only method of controlling a fire in a pulverized coal bin is to cut off the feed to the furnace and empty the bin as quickly as possible, with care to avoid raising a dust cloud that might be ignited by contact with the burning coal. Some manufacturers equip bins with air-tight valves, which may be closed in case of fire, sealing the bins and preventing the admission of air. This provision has proved effective in at least two instances.

If a dust explosion occurs under conditions that favor the building up of pressure, very high pressures may be obtained. In tests at the Bureau's experimental mine pressures as high as 119 lb. per sq.in. were developed in 750 ft. within 2.2 seconds. The advantage of light building construction is illustrated in a number of cases, where explosions have simply blown out wall panels or windows and done little other damage. Windows near the ground should not be glazed with wire glass, because in an emergency they may be the only means of escape for the men in the plant. Manufacturers of explosives often provide floor windows with safety catches so hung that in an emergency they may be swung open, permitting workmen to escape when doors are inaccessible.

How to Avoid Danger

The remedy for danger is good housekeeping. The plant must be kept clean and free from accumulations of coal dust on beams, window sills and other ledges. The use of vacuum cleaning machinery is to be commended. Compressed air for blowing dust from ledges is distinctly dangerous, inasmuch as it promotes the formation of clouds. Whitewashing the plant throughout is of considerable value in increasing the visibility of accumulations of coal dust and thereby facilitating the task of keeping the plant thoroughly clean.

There is an economic aspect to the question of cleanliness. It has been estimated that in some plants as high as 2½ per cent of the coal handled is lost as dust. In a plant handling any material quantity of coal a loss of this magnitude would go a long way toward defraying the cost of making the plant entirely dustproof. Plants can be made absolutely dustproof; the author has been in plants pulverizing 120 tons per day with hardly a speck of dust visible, even by drawing the tip of the finger along the walls.

The bulletin closes with a long list of concrete suggestions to promote safety.

*Abstract of Bulletin 212 of the United States Bureau of Mines, a booklet of 100 pages reporting laboratory and field studies.

Application and Operation of Diesel Engines*

By G. A. ADKINS and R. H. BACON†

DURING the last ten years the Diesel engine has become such an important factor in solving the problem of low-cost power production that engineers in every industry have become interested in studying the possibilities in the application of this prime mover to their own particular power problems. In order, however, to determine whether the Diesel engine will effect any substantial saving as compared with the cost of purchased power or steam power, it is necessary to analyze all the factors that affect the cost of power under the particular load conditions. Such a study must necessarily involve an analysis of the load conditions with a view to estimating the number and size of the Diesel engines that might be used, in order to determine the total power cost.

In making such a study, it should be kept in mind that the Diesel engine has certain fundamental operation characteristics that have a general effect on its application.

Diesel-electric generating sets parallel nicely, making it possible to install several to take care of the load, if the characteristics of the load are such as to make this economical. Multiple units add to the flexibility of the plant and increase the reliability in operation.

The fuel efficiency of the small engines is practically the same as that of the larger ones. This makes it possible to take advantage of the multiple-unit idea without loss in over-all plant efficiency. It also makes it possible to add units from time to time as the power requirements increase, with a result that the plant efficiency may even be bettered instead of being lowered as is the case with the steam engine or turbine.

The fuel-consumption curve for the Diesel engine is practically flat through the range from half to full load. For the lighter loads the fuel consumption per brake-horsepower output increases rapidly, as is also the case with steam engines or turbines. In laying out a plant, this characteristic should be carefully considered, for the total fuel consumption will be lowered if the Diesel units are so fitted to the load that no engine is operated at less than half load.

The lubricating-oil consumption is practically constant for any particular size of unit; that is, it does not vary with the load.

Studies of the more complex problems relating to the application of Diesel engines are beyond the scope of this paper. It is the purpose rather to take a typical load and show in a general way how the Diesel units may be fitted to this load and what the probable cost of operation will be. The load curve shown in Fig. 1 requires a peak load of 320 hp. and is a load of a type that would be encountered in the small municipal or public-utility power station or in the operation of a hotel or similar service. As a rule the industrial plant will have a different type of load curve, with the peaks during the hours when the greatest machine load is thrown on.

The load shown in the chart could be carried by a 360-hp. engine or two 180-hp. units, or three 120-hp. engines could be installed. The only way, however, by which it is possible to tell which is the most economical arrangement, is to calculate the probable power cost.

The fuel-consumption curves for a plant equipped with from one to four Diesel engines are shown in Fig. 2. If one engine is used, the total fuel consumption is based on the normal fuel guarantee curve for the engine. If two units are used, then when the load on the plant has reached 50 per cent of its total load or the total capacity of one engine, the other engine is started up and both engines are operated at 50 per cent load. In this case, as will be seen from the curves, the fuel consumption is the same as if one engine were operating at 50 per cent load. The other curves show the effect of putting 3 and 4 units. In each case the fuel consumption for those loads below 50 per cent of the plant capacity is much less than would be the case if one unit were installed.

It will be noted that the different combinations of units have been blocked in on the load curve in Fig. 1. The 360-hp. engine is represented by the entire block, and the two 180-hp. engines are shown by the dotted lines. The 120-hp. engines would be fitted to the load as shown. From Fig. 2 it will be found that at 20 per cent of plant capacity the 360-hp. engine would operate at a fuel rate of 0.82 lb. per brake horsepower-hour or would consume 61.6 lb. of fuel during the hour. The two 180-hp. engines could operate at a fuel rate of 0.54 lb. per brake horsepower-hour, as is shown by the dash-dot curve of Fig. 2. During the hour the fuel consumption for the two units would be 41.3 lb. The three units would operate at a fuel rate of 0.49 lb. per brake horsepower-hour, and the total consumption during the hour would be 36.8 pounds.

If the fuel consumption for the entire 24 hours is figured on this basis, it will be found that the 360-hp. unit consumes 2,095 lb. of fuel, or 279.3 gal. The two 180-hp. engines would consume 1,810 lb., or 241.3 gal. and the three 120-hp. units would consume 1,809 lb., which is approximately the same as the two-unit plant. The fuel consumption of the two- or three-unit plant would be approximately 16 per cent less than for the single unit. This reduction in fuel consumption does not, of course, take into account the slightly reduced efficiency of the smaller generators. This would reduce the saving somewhat, but would not change the relation materially.

Assuming that Fig. 1 is an average load curve for the year, the total horsepower-hour output would be 1,287,000, or allowing 12 per cent for generator and excitation losses, the kilowatt-hour

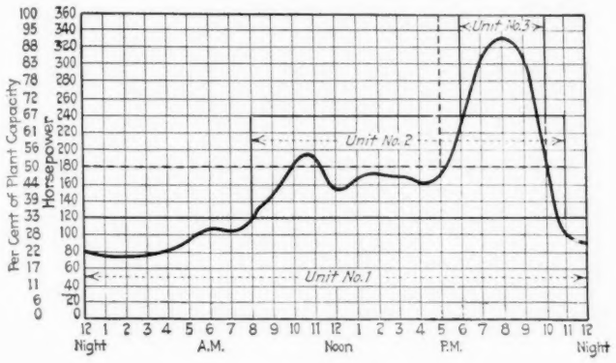


Fig. 1—Typical load curve of power plant

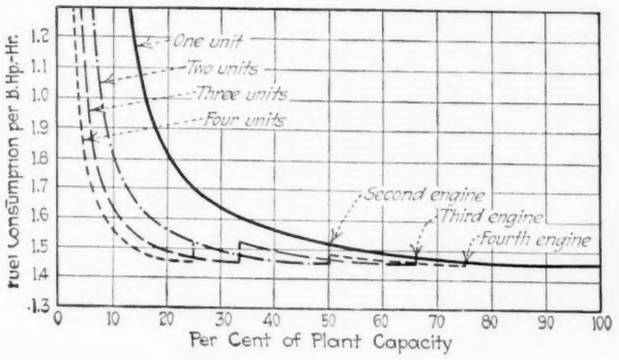


Fig. 2—Fuel consumption of Diesels at various plant outputs

*Abstract of paper presented before the Gas and Oil Power Conference, Chicago, Ill., April 21.

†Of Fairbanks, Morse & Co.

output would be 910,000 per year. Since the curve in Fig. 1 is an average curve for the year, the yearly plant factor would also be 41.7 per cent.

Fuel oil varies in price from about 3 to 8 cents per gallon, depending on the localities and quantity purchased. A large number of plants where the operating costs were recently analyzed show an average price of 5 cents a gallon when delivered in tank-car lots at a siding at the plant or near enough to allow the fuel to be pumped to storage.

Lubricating Oil Consumption

The next item of cost of operation to be considered is the lubricating-oil consumption. While this is necessarily higher for a Diesel engine than for a steam turbine, it is no longer a very important item in the cost of operation, for the reason that Diesel engines have been improved so much in this respect. A conservative guaranty for oil is 2,000 hp.-hr. per gal. This is the total oil used in all parts of the engine, no grease or other lubricant being required.

At this rate the 360-hp. engine would require a total of 1,577 gal. a year, costing $867. The two 180-hp. engines would each require 0.09 gal. an hour, and the yearly consumption would be 952 gal. at a cost of $526. The three 120-hp. engines would require 962 gal., costing $531.

From these figures it can be seen that the two-unit plant is not only better from the viewpoint of the fuel cost, but the lubrication costs are also lower.

Another item that has an important bearing on the total cost of operation is the cost of supervision. This item is about in line with steam-plant costs after the boiler room is eliminated.

The present-day Diesel engine is a comparatively simple machine, and while there are certain fundamental things that an operator must know, these are not beyond the understanding of any man who is capable of operating mechanical equipment of any kind such as ammonia compressors, steam engines and so forth.

Supervision Cost

The cost of operating supervision will be considerable, but for a plant of the size in question it is possible that a figure of $2,400 a year for the chief engineer and $1,800 a year for each of two assistants who would stand watch on the two other shifts, would cover this operating expense. Many plants of this size are actually operating at less than this figure, although it is questionable economy to cut too closely on the item of operating supervision. Careful operation of Diesel engines, as is the case with any other piece of machinery, will pay over a long period of years in reduced repair costs.

For estimating purposes, the installed cost of a Diesel engine and its accessories can be taken at $70 to $110 per horsepower. Where the engine is used for a mechanical drive and a new building or addition is not required, the cost ordinarily will not be over $75 per horsepower. Where an electrical plant of two or three units is to be installed, the cost ordinarily will range from $80 to $110 per horsepower, depending on the size of the units, type of building, etc.

A 360-hp. Diesel electric unit, exclusive of building, would cost about $30,000. This would include the installation ready for operation and would provide for fuel storage and all similar details. The plant equipped with two 180-hp. engines would cost about $32,500. These figures are, of course, satisfactory for general estimating purposes although they cannot be exact because of the number of variables that are included.

The cost of the building for a Diesel-engine plant varies so much that it has not been included in the total cost. In some cases engines are placed in buildings constructed of sheet iron, and in other cases the buildings are brick faced with limestone trim and with tile interior walls. The cost for the building, therefore, varies from $1,000 to $15,000 for a plant of this size.

Foundations for a Diesel engine of the airless injection two-stroke-cycle type would require about 40 yd. of concrete for a 120 hp. engine and alternator, and about 12 yd. additional for each increase of 60 hp. This, however, depends on the soil, and the cost will vary from $12 to $25 per yard, depending on the locality.

It is not uncommon to find in comparative estimates that the maintenance cost of the Diesel plant has been figured at 5 per cent of the total machinery cost. As a matter of fact, operating records in hundreds of Diesel-engine plants have shown that the maintenance cost of a Diesel is not excessive and that 2 per cent is ample to build up a fund that will cover all necessary repairs.

Fixed Charges

In making a study of power costs it is also necessary to consider the interest on the investment, depreciation, insurance and taxes, all of which are commonly listed under the heading "Fixed Charges."

It is necessary to consider this subject of fixed charges on a fair and unprejudiced basis. It is very easy to load up a plant with such fictitious fixed charges that all the gain through operating economy is offset. The advocates of purchased power are often inclined to stress the fixed charges, since that is the only possible argument against the economy of the Diesel generating plant.

Determining Depreciation Rate

Many engineers are now coming to the viewpoint that depreciation should be figured not on the probable life of the equipment, but rather from the consideration of how soon it is desired to write off the investment. There is no reason to assume that a Diesel plant kept in first-class condition from the maintenance fund which is set aside for that purpose, should not last indefinitely. Practically all the early Diesel engines that began operation in this country from 1900 to 1907 are still running and will probably continue to run for many years to come. This shows that an assumption of life from 25 to 30 years is not at all far-fetched.

There are not many managers of industrial plants, however, who would be willing to consider depreciating a plant over that long a period. For that reason 20 years has been selected as a reasonable time in which to write off the investment; on this basis a depreciation reserve of 2.72 per cent should be made, inasmuch as this percentage of the original investment set aside and compounded semi-annually will write off the total investment by the end of 20 years.

On this basis the total fixed charges for the plant would be: Interest, 6 per cent; depreciation, 2.72 per cent; taxes, 1.5 per cent; and insurance 1.5 per cent, or a total of 11.72 per cent.

From the analysis of operating costs it is now possible to tabulate the estimated cost of the Diesel plant equipped with the three combinations of units. This is shown in the accompanying tabulation.

From these figures it will be seen that the two 180-hp. engines appear to be the best combination from the viewpoint of actual operating costs. Under the particular load conditions the use of two engines would save $634 a year, which is good interest on the added investment of $2,500.

SUMMARY OF OPERATING COST FOR DIESEL PLANT USING ONE, TWO OR THREE UNITS, APPLYING THE LOAD CURVE OF FIG. 1

	1	2	3
Number of units			
Size of units, hp.	360	180	120
Fuel oil at 5c. per gal.	$5,070	$4,404	$4,400
Lubricating oil at 55c. per gal.	867	526	531
Labor	6,000	6,000	6,000
Maintenance, 2 per cent on 85 per cent of installation cost	500	550	600
Fixed charges, 11.72 per cent on total cost	3,511	3,809	3,984
Total operating cost	$16,248	$15,614	$15,855
Kw.-hr. output at 42 per cent yearly plant factor	910,000	910,000	910,000
Cost per kw.-hr. without fixed charges	$0.0178	$0.0171	$0.0174
Cost per kw.-hr. with fixed charges	$0.0140	$0.0129	$0.0130

Figuring the Combustible in the Ash

The following problem and solution shows how to figure the loss due to combustible in the ashpit refuse. The coal contains 12 per cent ash and has a heating value of 13,100 B.t.u. per pound. Analysis shows 15 per cent of combustible in the ashpit refuse. To compute the combustible loss, consider what happens when 100 lb. of coal is burned. It will contain 12 lb. of ash, which will get into the ashpit. There it will be mixed with combustible in the proportion of 15 parts combustible to 85 parts ash. Therefore the actual weight of combustible must be $15 \div 85 \times 12 = 2.11$ lb. for 100 lb. of coal, or 2.11 per cent. Allowing 14,600 B.t.u. per pound of combustible, this gives a heat loss of $2.12 \times 14{,}600 \div 13{,}100 = 2.4$ per cent.

Welding Society's Annual Meeting Features Design of Piping Systems and Pressure Vessels

FROM the viewpoint of the power-plant engineer, the Annual Meeting of the American Welding Society, held last week in the Engineering Societies Building, New York City, was notable for the contributions made to practical welding knowledge in the field of design, with particular reference to piping installations and pressure vessels. Other features were a review of progress in gas and arc welding, a general symposium on the subject of design, an inspection trip to the plant of the Metal and Thermit Corporation, a discussion of research problems by the American Bureau of welding and a dinner dance preceded by a spectacular demonstration of the properties of liquid oxygen.

New officers for the ensuing year were elected as follows:

F. M. Farmer, president; E. M. T. Ryder, first vice-president; R. L. Brown, A. M. Candy and Stuart Plumley, divisional vice-presidents; C. A. Adams, H. M. Hobart, A. E. Gaynor and A. G. Bissell, directors at large.

Three days, Wednesday (April 21), Thursday and Friday, were devoted to the various sessions. The meeting was the largest yet held, the total registration of 250 showing increased interest in the work of the Society and promising success for the fall meeting and exhibit, which will be held in Buffalo, N. Y., Nov. 14-20.

On Wednesday morning there was held a well-attended meeting of the Gas Welding Committee, of which S. W. Miller, head of the research laboratory of the Union Carbide & Carbon Corporation, is chairman.

Gas Welding Committee Discusses Research and Pressure-Vessel Code

At Mr. Miller's invitation, F. R. Low and C. W. Obert, chairman and secretary respectively of the A.S.M.E. Boiler Code Committee, spoke briefly on the Unfired Pressure Vessel Code and the attitude of the Code Committee on welding. It was pointed out that the committee has no actual authority in matters of construction. Its function was rather to crystallize and codify the best existing practice. There was no question in the minds of the committee, according to Mr. Obert, that good welding could be done. They merely felt it their duty to avoid giving sanction to practices not yet universally accepted as safe and conservative.

Mr. Low demonstrated the great interest of the Code Committee in welding by exhibiting the translation of an important German article on the subject which the committee had printed for the special purpose of further enlightening its members. The committee, said Mr. Low, were anxious to learn all the facts that had any bearing on the question of welded pressure vessels.

Two German engineers, Dr. K. P. Berthold, chief engineer of I. G. Farbenindustrie Aktiengesellschaft and Fr. H. H. Max Füchsel, chairman of the Welding Committee of the V. D. I. (German Engineers Society), conveyed the greetings of their colleagues and told of German practice in the matter of testing welds.

A report from the San Francisco section outlined the preliminary program for research on the strength of welds at high temperatures. This work, in which Leland Stanford University and the University of California are co-operating, will be limited at the start to welds made with commercial welding rods on ordinary firebox steel. After pointing out the significance of this study in connection with higher pressures in oil-cracking stills and steam boilers, Mr. Miller asked the members to give the San Francisco section the benefit of their experience with welds subjected to high temperatures.

The committee recommended that a special study be made with a view to standardizing tests for welders and ultimately preparing standards for procedure control for the various welding processes.

Electric Arc Welding Committee

The main feature of the meeting of the Electric Arc Welding Committee on Wednesday afternoon was a discussion of the results of tests made to determine the effect of such factors as current, size of electrodes, design of joints, positions of welding, etc., as presented by the subcommittee on the Fundamentals of Arc Welding.

This was preceded by a report of the subcommittee on Non-Ferrous Metals. One member reported success in welding aluminum with the electric arc. Another told of the Niagara Power Company's practice in the matter of repairing eroded impellers of hydraulic turbines. These are renewed by arc welding with phosphor-bronze rods.

In a discussion of single-V versus double-V welds (in steel plate) several spoke in favor of the single-V weld as ample for many purposes. Samples were shown of square-end and single-V welds made with a grooved copper backing plate to give excess metal on the back side. The results of tests to determine the effects of size of electrodes, design of joints and other factors on the properties of electric arc welds were presented by H. L. Warner, of the General Electric Co. There was some disagreement as to the interpretation of the results obtained. The tests seemed to prove, among other things, that the single-V weld was as good as the double-V and that a V angle of 60 deg. was best.

There was much discussion of the reliability of welding, and it was generally agreed that a strength of 36,000 to 40,000 lb. could be absolutely depended upon with properly trained welders.

President Oehler, at the Thursday morning business session, pointed out a number of important accomplishments of the Society during the last year. Outstanding in these he listed the Fall Meeting of the Society in Boston and the exhibition at which several thousand people witnessed the working exhibits held in conjunction with this meeting. Another accomplishment of far-reaching importance was the authorization of the Council of the A.S.M.E. to join with the Welding Society in a proposed $100,000 joint investigation in the field of welded pressure vessels.

Piping Installations for Steam, Air and Refrigeration

Several of the papers at the Thursday afternoon session were of particular interest to power-plant engineers, both designers and operators. That of L. J. Sforzini on "Design of Joints in Piping Installations," was a notable contribution to the literature of practical welding by one thoroughly conversant with the problem of handling steam, air, ammonia and brine in a large industrial establishment.

S. W. Miller of the Union Carbide and Carbon Research Laboratories, presented a paper on the "Design of Welded Joints with Special Reference to Pressure Vessels," while L. H. Burkhart illustrated design methods by the details of design and manufacture of a welded pressure vessel to meet specific requirements. Abstracts of these three papers will appear in early issues of *Power*.

A paper of principal interest to tank and container manufacturers was that of A. C. Vick on "Gas Welded Longitudinal Seams for Stringent Requirements." Only one paper, which dealt with ship construction, was entirely out of the power field.

E. E. Thum, in a paper on the design of welded joints, outlined the general principles governing the making of satisfactory gas-welded joints.

Mr. Sforzini discussed in detail the design of piping installations, pointing out where welding should and should not be used. He also gave specific instructions for making various types of joints, fittings, outlets, etc., for steam (high pressure and low), air, ammonia and brine. His paper emphasized costs, safety, etc., and concluded with the following summary:

"The welded pipe joint is a satisfactory joint, easy to make, comparatively cheap for large-sized pipe or for high-pressure pipe, is a time saver, gives the designer perfect freedom in piping layout, and once made tight, stays tight. It saves in insulation cost, and it reduces the coal bill even if unappreciable in amount. Its use

makes possible certain economies in the industrial power plant pertaining to steam distribution, in permitting concentration of power and heat production. Low-pressure steam distribution can be made in very cheap steel mains of large size, which has the advantage of permitting additions at low cost. It is the writer's opinion, based on experience, that welded piping installed under proper supervision is fully as reliable as any of the other ordinary joints. True, a welded joint has resulted in failure now and then, but so have the other type of joints. Cast-iron fittings frequently fail, riveted vessels fail often, and gasket blowouts are a common occurrence.

"Welded joints have been scrutinized for defects and each defect magnified. But in a certain measure this close observance is beneficial, for it has taught caution in a comparatively new art. The fact that welded piping is now in such extensive use, and its use increasing day by day, indicates that criticism has not been in vain.

"This precaution must not be so stringent as to throttle welding, but must be rigid enough to secure against failure. The best precaution possible is to use only welders and welded material of known reliability, i.e., deal only with fabricators and welders who value their reputation.

"The piping designer should co-operate with the maker of welded material; he should properly allow for all stresses, expansion, pressure or otherwise. And, if possible, he should keep welds, unless properly reinforced, away from points of maximum stress. Welding is a most important tool to the piping designer, and he shou'd understand both its possibilties and limitations."

Mr. Burkhart's paper worked out the detailed design for a horizontal cylindrical pressure tank 15 ft. long and 48 in. in diameter for a steam or air pressure of 250 lb.

Mr. Thum listed the following principles controlling gas welding:

1. Arrange for complete flame penetration without overheating.
2. Avoid wide differences of metal cross-section at the weld.
3. Avoid placing a weld under compound stress.
4. Avoid intersections of welds meeting at a cross.

Weld "Efficiency" of Little Significance

Mr. Miller spoke, among other things, about the four commercial qualities of sheet steel—firebox, flange, ship and tank, arranged in order of quality. Firebox steel, he said, should be used for all important work. This material has a tensile strength of from 55,000 to 65,000 lb. per sq.in. and a minimum yield point of one-half the tensile strength. Mr. Miller pointed out that higher tensile strengths were of no advantage in welded work, because the work could be no stronger than the weld. The strength of weld metal in a fusion weld made with ordinary low-carbon steel welding wire and of the double-V type is about 50,000 lb. per sq.in. It is evident, he pointed out, that weld "efficiency" means nothing unless consideration is given to the strength of the sheet. When this is high, the efficiency is necessarily low. The double-V weld was said to be stronger and more reliable than the single-V. A maximum safe working stress of 8,000 lb. was recommended for this type of weld.

The principal social feature of the annual meeting was a dinner dance held Thursday evening in the Rose Room of the Hotel Astor. This was the first time that ladies had been invited to the annual dinner. In addition to a very good dinner, professional entertainment and dancing, there were short addresses by the incoming and outgoing presidents, and an interesting demonstration of the wonders of liquid oxygen. Among other things, mercury was frozen and used as a hammer to drive nails. A rubber ball was frozen so stiff that it cracked like glass when struck with a hammer. An egg was "boiled" hard by means of the liquid oxygen.

Research Stressed at Bureau Meeting

The annual meeting of the American Bureau of Welding, which is the research department of the Society, took place Friday morning, April 23. Prof. C. A. Adams stressed the importance of fundamental research in the welding field. Some fundamental problems needing investigation in the electric-arc, gas-welding, pressure-vessel and structural welding field were outlined by Messrs. H. M. Hobart, S. W. Miller, H. L. Whittemore and J. H. Edwards.

Two important investigations are being proposed; one in the field of unfired pressure vessels as a joint investigation with the A.S.M.E. to secure information needed by the Boiler Code Committee and designing engineers. National Research Council will be asked to act as treasurer of the funds needed. The other investigation is being proposed in the field of fabrication of structural steel in which co-operation is being sought from the American Institute of Steel Construction.

Notes on European Power Plant Practice

By A. C. Blackwall

Some of the new power plants that were either put into operation or practically completed during the year 1925 are of especial interest from the standpoint of the boiler plant. In Great Britain the first section of the 100,000-kw. Barking station, the largest in the country, contains ten boilers, five of the B. & W. type with chain-grate stokers and five of the Yarrow type with underfeed forced-draught traveling-grate stokers, in addition to four other boilers for reheating the steam between stages of the turbines. The steam pressure is 375 lb. gage and the total steam temperature 700 deg. F. Air heating is employed. The North Wilford station, at Nottingham, contains at present six Stirling boilers, each of 55,000 lb. normal evaporation with underfeed stokers and water trough ash conveyors. The steam pressure is 250 lb. gage, with the total temperature 650 deg. F.

In Germany the New Rummelsburg station, at Berlin, which is being constructed on the River Spree from the designs of Dr. H. Klingenberg, will eventually be of 500,000 to 600,000 kw. capacity. Three turbo-generators of 70,000 kw. each are being installed, with three smaller units of 10,000 kw. each, which drive all the auxiliary plant and provide steam for feed-water heating, instead of the usual method of bleeding from the main turbines. The steam-generating plant consists of sixteen boilers, each with 19,450 sq.ft. of heating surface and a normal evaporation of about 200,000 lb. of water per hour, at 500 lb. per square inch and 750 deg. F.

There was an important increase in the application of pulverized fuel firing during the year. The installation at Birmingham for six boilers of 5,400 sq.ft. heating surface was set to work. Advances are being made in the unit pulverizer, and individual units capable of burning 10,000 lb. of coal per hour are now available, and pulverized coal is being conveyed for a distance of more than 5,000 ft., using only about 1 per cent of the air required for combustion. Attention is also being directed to the possibilities of using low-temperature coke as pulverized fuel.

Considerably greater use is being made of the principle of chlorinating cooling water to prevent the growth of organic deposits on condenser tubes, as well as in cooling towers.

Increased attention is being paid to the use of instruments of control and the efficient operation of the boiler house on scientific principles. Steam meters, boiler-feed meters, continuous coal-weighing equipment, pyrometers and instruments for the analysis of the flue gases are now being regarded more and more as essential to efficient working, and pyrometers for turbine bearings and air circulation, and meters for make-up, circulating and cooling water are being adopted.

Statistics of the output of electricity in Great Britain for the year ended March 31, 1925, for 584 generating stations, showed an increase in efficiency of 6 per cent and in output of 11 per cent. The average coal consumption was 2.53 lb. per kilowatt-hour. This, of course, includes a large number of out-of-date plants.

Run the Grain Side of Belt on the Pulley

The strongest part of belt leather is about one-third the way through from the flesh or rough side. It is therefore desirable to run the grain or smooth side on the pulley so that the strongest part of the belt may be subject to the least wear.

The flesh side is not as liable to crack as the grain side when the belt is old, hence it is better to crimp the grain than to stretch it.

But more convincing still: The Cornell experiments have established the fact that under reasonable shop tension the flesh side will transmit but 35 per cent to 80 per cent as much power as the grain side, with an average of 50 per cent to 60 per cent, depending on the belt, the tension, etc.—*Extract from "Belt User's Book," J. E. Rhoades & Sons.*

News in the Field of Power

Secretary Work Outlines Plan Financing Colorado River Development

Addresses Californians on States' Co-operation—Proposes Fund from Government Bonds—Large Revenue from Power To Return Expenditure

URGING a complete interstate and national agreement in favor of early action in the long proposed development of the lower Colorado River, known as the Boulder Dam, Secretary of the Interior, Hubert Work, outlined the plan of financing the enterprise in an address read before the Los Angeles City Club on April 26.

MEASURE AWAITS ACTION

"For the first time, during the present session of Congress," said Secretary Work, reviewing the history of the proposed development, "concrete and specific recommendations, comprehending the diversified and co-ordinated use of the river, were made to Congress by the present administration of the Interior, which reported frankly and carefully on this bill. Proposals by the Department for certain changes in the bill were immediately approved by its authors, and today the measure is awaiting definite action by Congress. Delay in the enactment is being caused by the inertia which all great undertakings encounter, and the necessity for adjusting rival and conflicting views. It is urgent that these be reconciled speedily.

"My proposal that the funds needed for this entire development be obtained from the sale of government bonds was made because it was believed that enough revenue can be obtained from the sale of water for irrigation and domestic use, and the sale of power, to make this a solvent undertaking, paying interest on all the money expended and returning the principal within a reasonable time. To finance the enterprise in this way would remove a serious objection from taxpayers in other parts of the country, as it may be possible to make the project a self-sustaining one without disturbance in the fiscal operations of the government.

CORRELATION NEEDED

"I am opposed to government ownership or operation of any activity that is within the compass of private citizens. For the last five years I have been directing government services under the mandate to 'centralize authority and decentralize responsibility.' But conflicting and diversified interests are involved in the Colorado River development that compel a closely knit organization to correlate them.

"No individual or corporate entity, licensed for totally different and diversified purposes, could be found to guard one interest and equally protect the rights of others. The citizens' rights of appeal is their due against unfair advantage by monopolistic utilities, but no local authority can compel services from a company not included in their charter, or for which they are not paid to perform. States' rights for civil protection and local industrial development is fundamentally sound in theory, and essential to a proper functioning of the federal government.

"Yet, changing conditions have waged an economic, social, industrial and governmental revolution in this country in the last ten years. The World War broke down precedents and practices and, because of our readjustments, we would not seem to appear as a new nation. Larger corporations and mergers are a necessity because of these conditions. Men's views, too, must change to meet them.

"This tremendous engineering task, if achieved, will rescue from menace the homes of 60,000 people and farms valued at $60,000,000. Doubling the reclaimed area, where climate contributes the greatest value to irrigated crops, the development will bring certainty and security of an increased water supply to Denver and Los Angeles alike, both cities of the arid region and outside the river's watershed. A marked industrial growth will be assured these centers due to the creation of a great volume of cheap power.

TEN YEARS WORK

"Should Congress fail to instruct the Secretary of the Interior to secure contracts for the sale of power and water from the Colorado River to potential consumers, he proposes to initiate such procedure himself and, if possible, have formulated something tangible to present to Congress when it meets next winter. These proposals will have to be of a general character, because work of this magnitude will require from five to ten years to complete and the proposals will have to be for a service which does not begin now but at least five years in the future. This fact is the most potent argument for early authorization to construct.

"No structures heretofore built for any of the purposes indicated promised a cash return, except reclamation. The proposed Boulder Dam Bill promises to utilize the water it will store, to amortize its costs, and even now some twenty-five applications from private parties are pending for permits to build power plants on the higher reaches of the Colorado River.

"It is my belief that as soon as the Boulder Dam Legislation has been approved by Congress," concludes Secretary Work, "the applications for private power development should have immediate consideration. There does not seem, to my mind, to be any danger that the power market will be oversupplied. On the contrary, cheap power will help to open up new mines, promote the building of new railroads and multiply industries."

Crawford Ave. Station to Have 120,000-Kw. Unit

A cross-compound turbine half again as large as any now in commercial service, and larger than any under construction is to be added to the equipment of the Crawford Avenue Station of the Commonwealth Edison Co. of Chicago. The new unit will be rated at 90,000 kw., equivalent to 120,000 hp., and will be furnished by the General Electric Co., which has practically completed a 77,000-kw. unit for the same station.

The turbine will consist of two sections, a high-pressure element of 35,000 kw. capacity, running at 1,800 r.p.m., and a low-pressure element of 55,000-kw. and 1,200 r.p.m. A 2,000-kw. service generator is connected to the high-pressure element, and a 500-kw. direct-connected exciter to the low-pressure element.

Operating conditions will be the same as for the other units in the station, with steam at 550 lb. gage and 750 deg. total temperature.

The enormous size of the 90,000-kw. unit is indicated by the following overall dimensions: Length of high-pressure element 71 ft. and low-pressure 53 ft.; height 13 ft. 6 in. The total weight will be 1,978,000 lb.

The addition of the 90,000-kw. turbine will bring the installed capacity of the Crawford Avenue station to 327,000 kw. It is expected that the ultimate capacity of the station will reach 750,000 kw. or more.

Big Paper Mills To Push Grand Falls Development

Immediate development of Grand Falls, on the St. John River, province of New Brunswick, is assured through the completion of the agreement between the International Paper Co., the Fraser Companies and the provincial government it was learned recently. Under the provisions of the agreement a block of 20,000 hp.—13,000 primary power and 7,000 secondary power—is reserved for the Fraser Companies, who will embark in the newsprint business with the construction of a 200-ton daily capacity mill.

Ontario Hydro Commission Contracts for 260,000 Hp. from International Paper Company, Ottawa

Delivery of Energy at $15 per Hp. to Be Completed in 1931—Service To Continue Thirty Years—To Connect With Niagara System

ONE of the most striking advances in the history of power development in Canada has been achieved by the Ontario Hydro Electric Power Commission, which has just completed an agreement for the delivery by the Gatineau Power Company, at the interprovincial boundary in the vicinity of Ottawa, Ontario, of from 230,000 to 260,000 hp. of hydro-electric energy at a price of $15 per horsepower. The first block of 80,000 hp. will be delivered in 1928, and the total delivery is to be completed in 1931. The contract binding the delivery is for 30 years, dated from 1928.

The Gatineau Power Co. is a subsidiary of the International Paper Co., which is at the present time constructing huge power plants on the Gatineau River at Chelsea and Farmer's Rapids, a few miles from Ottawa, from which developments certain amounts of power will be delivered under the contract just concluded. The International Paper Co. is at present negotiating with the Hull Electric Co., a subsidiary of the Canadian Pacific Railway, for the purchase of Paugan Falls on the Gatineau River, which is capable of a development of about 150,000 hp. If this development is carried out the company will have an available supply of more than 250,000 hp. from these three sites. In addition, however, the company controls a number of other important power sites on the Gatineau river which it proposes to develop.

The power to be delivered to the Ontario Commission will be transmitted at a point near Ottawa, to connect with the Niagara system near Toronto. The transmission lines will be approximately 230 miles in length and will require an expenditure of from $10,000,000 to $15,000,000.

Experts To Advise on M.I.T. Gas and Fuel Course

According to anonuncement, President S. W. Stratton of the Massachusetts Institute of Technology has appointed the following as an advisory committee on the new course in Gas and Fuel Engineering, established this year at the institute in order to assure closer academic contact with the fuel producing and fuel using industries:

W. R. Addicks, Vice-Pres. Consolidated Gas Company of N. Y.; A. M. Barnes, Pres. Cambridge Gas Light Co., Cambridge, Mass.; Walter Barnum, Pres. Pacific Coast Coal Co.; D. D. Barnum, Pres. Boston Consolidated Gas Co.; H. L. Doherty, Pres. H. L. Doherty & Co.; F. A. Howard, Vice-Pres. Standard Development Co.; J. B. Klumpp, Vice-Pres. United Gas Improvement Co.; F. R. Low, Editor of *Power*, McGraw-Hill Book Co.; R. M. Searle, Pres., Rochester Gas & Electric Corp.; W. E. Steinwedell, Sec., Gas Machinery Co.; T. R. Weymouth, Pres., Iroquois Gas Company.

Two More Power Plants for New York Hospitals

Two bills of appropriation for the construction of power houses for New York State hospitals were signed by Governor Smith at Albany April 19.

One bill authorizes the sale of bonds to the amount of $200,000 for the construction of a power house at the New York State Hospital for Incipient Pulmonary Tuberculosis at Raybrook. The Governor also signed the Allen Bill calling for the creation of a debt of $750,000 for the buying of a site and the construction of a central power plant for Matteawan State Hospital for the Criminal Insane.

Muscle Shoals To Be Sold at Auction

Acting on the suggestion of the President, the negotiations for Muscle Shoals have taken on the form of an auction. Those who have submitted offers have been called in and are being asked to overbid the others. The President's opposition to any plan which will require further expenditures by the government also has injected a new factor into the negotiations.

It is apparent that the full influence of the farm bloc is behind the American Cyanamide Company's offer. It is being represented by some that the struggle is between the farmers and the power interests. Others point out that no one of the bidders is sure enough as to nitrogen manufacture to pledge very much in the way of fertilizer, so that the farmer has little chance of being an important beneficiary of any offer. Some see in the negotiations efforts on the part of two competitive groups of power companies to gain an advantage each over the other. Those holding this view argue that as the Cyanamide company is a Duke interest it is greatly interested in power. To gain a foothold on the Tennessee River would be a protection against inroads from the south into the field now being served by the Duke companies.

To offset the farmer support for the Cyanamide offer, the Alabama Power Company and the companies associated with it in the offer for Muscle Shoals seem to have important labor support from those interested in the growth of industry in the states which they serve.

Major J. H. Burns, of the Ordnance Department of the Army, the original chairman of the committee, became persona non grata with some members of the Congressional Committee, it is understood, when he stated that the Army is not greatly interested in Muscle Shoals as the source of nitrogen, as it probably would be manufactured elsewhere in case of war. Major Max Tyler, of the Corps of Engineers, seems to have insisted too strongly that there is no need of disposing of Muscle Shoals at a bargain price. O. C. Merrill, the executive secretary of the Federal Power Commission, also retired from service on the committee.

The Union Carbide Co. has made public some of its conclusions derived from investigations of the Muscle Shoals problem. That company believes that Nitrate Plant No. 2 is far from obsolete. It believes that the national defense can be furthered greatly through the establishment of local electrochemical and electrometallurgy industries at Muscle Shoals.

It also has gone on record to the effect that hydro-electric power "can be made available in reasonable amounts for general distribution beyond the needs of national defense, agriculture and local industry."

Dinner Given International Electrotechnical Men

Greeting the visiting delegates to the 1926 New York meeting of the International Electrotechnical Commission, the electric light and power companies of New York entertained that body with a dinner at Hotel Astor, New York City, April 19.

C. E. Skinner, chairman of the American Engineering Standards Committee, and leader of the forthcoming tour of the Eastern power plants, gave a brief talk. C. Le Maistre, Great Britain, general secretary of the commission, addressed thanks on the part of the visitors to Dr. Clayton H. Sharp, president of United States National Committee, Dr. John W. Lieb, vice-president-general manager, New York Edison Co., and F. W. Smith, vice-president-general manager, United Electric Light & Power Co.

Mayor James J. Walker, Gr. Uff. Guido Semenza, president of the commission, Ing. Domingo Santa Maria, delegate from Chile, and others, made short remarks. L. Lombardi, president of the Italian committee, read Italy's invitation to hold the next meeting in Rome.

Westinghouse Announces 1926 Memorial Scholarship Plans

Westinghouse Electric & Manufacturing Company has just announced the plans for awarding the 1926 War Memorial Scholarships. These awards are made annually, the successful candidate receiving $500 during each year of his collegiate training, or a maximum of $2,000.

Applicants eligible to compete for these Scholarships include sons of employees who have been with the company five years or more, and employees who have been continuously in the service for at least two years and who shall not, on September 1, have exceeded the age of 23.

International Electrotechnical Body Holds Successful Convention

Advisory Committees Discuss Both Electrical and Mechanical Topics—Steam and Hydraulic Turbines Considered

THE results of the deliberations of the various advisory and other committees of which the meeting of the International Electrotechnical Commission largely consists were reported to and considered by the full Commission in Plenary Meeting on Wednesday afternoon April 21.

It was announced that the Council had unanimously re-elected Senor Guido Semenza as president and had accepted the invitation of the Italian delegation to hold the next meeting in that country. The date will be fixed by the Council probably late in the summer of 1927 and the meeting may be plenary or simply of those of the advisory committees ready to go on with their work.

Col. R. E. Crompton, was advanced from Honorary Secretary to Honorary President and Sir Richard Glazebrook, K.C.B. was made Honorary Secretary in his place.

Reports were submitted for the following advisory committees:

Nomenclature,
Prof. M. Chatelain. Russia.
Rating,
Prof. C. Feldmann. Holland.
Symbols,
Lt. Col. K. Edgcumbe. Great Britain.
Prime Movers,
Dr. Wm. F. Durand. U. S. A.
Caps and Holders,
Dr. Clayton H. Sharp. U. S. A.
Standard Voltages,
Prof. L. Lombardi. Italy.
Traction Motors,
M. E. Roth. France.
Rules and Regulations,
E. Uytborck. Belgium.
Insulating Oil,
W. H. Fulweiler. U. S. A.
Terminal Markings,
Prof. Dr. P. Strecker. Germany.

The committee on symbols reported in favor of the Greek letter Ω (omega) for the ohm, and this was adopted.

International Steam and Hydraulic Turbine Codes Formulated

The development of international codes for steam and hydraulic turbines, to cover both commercial and technical matters, is one of the objects of the International Electrotechnical Commission, and this work has been actively prosecuted by its Advisory Committee on Prime Movers during the New York Meeting of the Commission, April 13 to 23, under the chairmanship of Dr. W. F. Durand, Past President of the A.S.M.E.

The plan is to develop a code in four parts. Part I will define certain technical terms whose meaning must be exactly established in the conduct of commercial negotiations. Part II will present an itemized schedule of the information that must be furnished in connection with an inquiry or order addressed to a manufacturer. Part III will set forth certain commercial considerations which must be observed in testing turbines to determine their conformity with guarantees, and Part IV will be a comprehensive technical code of testing methods of the type now being prepared by the A.S.M.E. as a guide to practice in this country. The international document will doubtless be more extensive than the A.S.M.E. Codes, because it must embody practices for other countries than the United States.

Bronze statute of Victory—the marble base bearing the following inscription:

International Electrotechnical Commission
Presented to the United States National Committee by President Guido Semenza on behalf of the visiting members on the occasion of the plenary meeting in New York, April 13 to 23, 1926.

The engineering profession in the United States is co-operating in this undertaking through the Power Test Codes Committee of the A.S.M.E., whose chairman, Dr. F. R. Low, Editor of *Power*, is the official delegate on steam turbines, with H. Birchard Taylor as the official delegate on hydraulic turbines. Mr. Taylor is chairman of the A.S.M.E. Committee engaged in revising the A.S.M.E. Test Code for Hydraulic Turbines. Several other members of the Committees on steam and hydraulic turbines, including C. H. Berry, Associate Editor of *Power*, Chairman of the A.S.M.E. Committee on the Test Code for Steam Turbines, are actively engaged in the I.E.C. Committee work, and during the recent meeting they were supported by experts from various manufacturers in this country.

In view of the growing unity of the world in the field of engineering, the growth of a movement of this nature is of the first importance, and it is to be hoped that the work of the I.E.C. will be heartily supported by engineering societies and manufacturers throughout the world.

The preparation of international codes in the mechanical field is a new venture for the I.E.C., whose work has for twenty years been confined to electrical matters, but this organization seems to be the only one in the field, and this extension of its scope meets with the approval of many engineers and organizations interested in the development of international accord in such matters. While the task is a big one, an effective committee organization already exists, and will be extended by the addition of qualified men, so that steady progress is expected.

An allied project of importance to be undertaken by another committee of the Commission is the establishment of an international schedule of symbols in the field of hydraulic and heat power engineering. The A.E.S.C. Committee on this subject has agreed to defer to the I.E.C. in this work, and has submitted its recommendations.

To Mold Future Practice

These documents are designed not merely to give expression to current practice, but to lead to the development of modifications in the direction of justice to both manufacturer and purchaser of equipment on a basis of uniformity which should greatly simplify international interchange of both equipment and information.

Among the questions approved for submission to the National Committees were the elimination of tolerances in meeting guarantees, the suppression of the horsepower and the use of the kilowatt, which, it is remarked, is a mechanical unit, and the refusal to set up numerical values of corrections for deviations in operating conditions.

During the New York meeting much time has been spent by several capable committees in planning this work and establishing fundamental principles to guide future activity. In this there has been a splendid spirit of co-operation shown by the delegates from ten or a dozen countries of Europe and South America. It is apparent that the work will not be hindered by any narrow nationalistic views; indeed it is increasingly obvious that capable engineers are in accord the world over, and that views of what constitutes sound practice know no political boundaries.

Closing Dinner

On Wednesday evening April 21 a dinner was tendered by the visiting delegates to the United States Committee at the Hotel Astor. President Semenza presented a suitably inscribed bronze statuette of Victory, shown in the accompanying engraving which was fittingly acknowledged by Dr. Clayton H. Sharp. The following speakers were charged with the expression of the thanks of the visitors each to some group of the lists. Lt.-Col. K. Edgcumbe, Great Britain, to the U. S. National Committee; M. E. Roth of France, to the A.I.E.E.; A. F. Enstrom, Sweden, the New York Electric Companies; Dr. Prof. P. Strecker, Germany, the Engineering Societies; Prof. M. Chatelain, Russia, the Reception Committee; S. Yoshiwara, Japan, the Entertainment Committee; Mrs. Enstrom, the Ladies. Remarks were also made by Colonel Crompton the newly elected Honorary President and C. O. Mailloux.

Discusses Tendencies in Steam Generating Units

There is a marked tendency to expose more of the boiler-tube surface to radiant heat and less to the convection heat of the gases, according to Pell W. Foster, of the Power Specialty Co., speaking before the A.S.M.E. at Providence on April 9.

The convection heating surface which is being taken out of the boiler is being replaced by more efficient heating surface in an economizer or an air heater designed for counter-current flow. Aside from these changes to secure better over-all efficiency, certain changes in the design of the boiler have been made for the purpose of adapting its construction for the higher operating pressures that are being used today.

In the discussion of auxiliaries the speaker emphasized the necessity for the cooling of the furnace walls on account of the high furnace temperatures that result from the high rates of combustion now used. In a comparison between air-cooled and water-cooled walls the more effective work of the water-cooled walls, particularly as regards the increase of boiler capacity, was pointed out. It was stated however, that the main advantage of water walls is in the reduction of maintenance on the brickwork, and the shorter and less frequent outage periods of the boiler to repair the setting.

Analysis was made of the advantages of the various locations in which superheating surface could be installed to obtain the high superheats that are now in demand. The speaker discussed in detail the advantages of a combination superheater, consisting of a convection-type superheater connected in series with a radiant heat superheater in one of the walls of the furnace. Slides showing the performance of the combination type as obtained in operation, indicated the tendency for a decrease in superheat with an increase in boiler rating in the radiant-heat section as offsetting the tendency of the superheat in the convection section of the superheater to increase with greater load on the boiler.

In discussing and comparing air preheaters and economizers Mr. Pell was of the opinion that, although the same over-all efficiency would be obtained on the boiler by the use of either air preheaters or economizers, the economizer gives an increase in the capacity of the boiler which the air preheater does not.

Consolidated Gas Company Enlarges Home

When the old Academy of Music, 14th to 15th Street, has been torn down in May, the Consolidated Gas Co., of New York, will construct its new building on the site, enlarging its present home on the southeast corner of 15th Street for its exclusive occupancy and the housing of its affiliated firms, including the New York Edison Co. and the United Electric Light and Power Co.

Part of the edifice, including the tower, will represent an expenditure of $7,500,000, and, with the present building, it will bring the investment of the company to $12,000,000.

Electrical Engineering Draws Most Students

Enrollment in engineering colleges in the United States, for the year 1925-'26, is 56,332, according to report from the Bureau of Education, Washington. Covering 143 educational institutions where the branches of engineering are taught, the statistics show that 18,204 students studied electrical engineering. Those taking civil engineering totaled 12,502; while the mechanical branch ranked third, with 10,662 disciples.

Oil a Factor in Decreased Coal Consumption

The greatly increased competition of fuel oil, general industrial depression following the war period and reconstruction, the economies practiced through highly efficient electrical utilities, and the further development of water power,—these combined factors throw much light on the world-wide depression in the coal industry, as viewed through the estimates of The American Petroleum Institute on oil production.

While the past year shows a total of 1,066,220,000 barrels of petroleum produced, a larger production by more than 54,000,000 barrels in 1924, the world production of coal for the same year was only 26,000,000 tons greater than it was in 1913, or 1,368,000,000. Running parallel with the necessary substitution of oil for coal, developed from 1920 to the present time the steady displacement of much coal by the rapid increase of waterpower. In 1922 this form of power was displacing 91,000,000 tons of coal; by 1923 further hydro development was resulting in the displacement of 116,000,000 of tons.

At the same time economies in the use of coal have reduced the amount consumed. The electric utilities have reduced their unit consumption per kilowatt-hour by forty per cent, and the railroads and steamship companies have succeeded in increasing efficiency.

"Hydro Power at St. Lawrence Boundary Less," Says F. A. Gaby

Chief Engineer F. A. Gaby, of the Ontario Hydro Electric Power Commission, has taken issue with Colonel Hugh Cooper, who recently told the New York State Waterpower Commission that 2,400,000 horsepower of continuous energy could be developed on the international section of the St. Lawrence river at a point 40 miles below Ogdensburg. Mr. Gaby says this is impossible. "Colonel Cooper must have been referring to connected load," said Mr. Gaby in an interview.

The Hydro Commission's estimate of power to be had from a single stage development of 74.5 foot head is 1,861,840 hp., Mr. Gaby said. This compares with the head of 83 feet proposed by Colonel Cooper.

Favors Stenciled Words For Piping Systems

A committee of national scope, on which several government departments are represented, including the Bureau of Standards, formed to consider the proposed plan for identifying the contents of piping systems used in manufacturing plants and power stations, under the procedure of the American Engineering Standards Committee, has reported in favor of the use of stenciled words rather than colors for the detailed identification of the contents of the pipes.

Certain objections to the scheme have been offered by power men, architects and others, and these were duly considered.

Appointed to Represent U. S. on Niagara Control Board

The Secretary of War has named Major Dewitt C. Jones, Corps of Engineers, as the representative of the United States on the Niagara Control Board, created by agreement between the governments of the United States and Canada for the purpose of obtaining closer co-operation in the matter of controlling the amount of water diverted from Niagara River for generation of hydro-electric power.

Exports in Power Field February, 1926

In export to foreign countries, Venezuela bought the largest number of steam engines, with Canada second in purchases. Mexico took the largest number of power pumps. Australia tied with Canada in the number of Diesels and semi-Diesels. United Kingdom together with Canada bought nearly half the total export in ice-making and refrigerating equipment. Below are some principal statistics of the period:

Item	Number	Dollars
Steam engines	45	56,444
Boilers	54,936 sq.ft. h.s.	112,674
Steam pumps	545	188,440
Centrifugal pumps	160	50,844
Steam turbines	7	74,695
Diesels and semi-Diesels	50	48,146

Society Affairs

The School of Engineering, Johns Hopkins University, Baltimore, will be addressed by C. F. Hirshfeld, head of the research department of the Detroit Edison Company, in a lecture entitled "How Long Shall We Live?" on April 28. The question will be treated from the point of view of the development of science as applied to engineering and its effects upon the social structure.

The American Society of Mechanical Engineers gave a luncheon on April 20 at the Engineers Club, New York City, to the delegates to the Third International Standardization Conference, at which Past President Dr. W. F. Durand presided. Brief addresses were made by Prof. Curt Hoenig, of Switzerland, Senor Santa Maria, of Chile, and Dr. Otto Kienzle, of Germany.

Personal Mention

William H. Scott is now with the Iowa Electric Co. at Cedar Rapids, Iowa.

Robert W. Munro, formerly of the West Penn Power Co., is now connected with the Griscom-Russell Co., New York City.

F. W. Leahy, well-known marine engineer, has been appointed chief engineer of the Campbells Creek Coal Co., Cincinnati, Ohio.

William M. Bostwick has left the Texas Power & Light Co. to accept a position as mechanical engineer with the Florida Power & Light Co., Miami, Fla.

Frank S. Clark, mechanical engineer with Stone & Webster, Inc., Boston, Mass., has been made consulting engineer on steam-power station layouts, design and research.

William Jorgenson, recently with the Brooklyn Edison Company as a mechanical engineer in charge of equipment, has joined the steam boiler division of the American Brown Boveri Electric Corp.

George W. Thurnen has left the employ of the San Joaquin Light & Power Corp. to become sales representative for the Electrical Products Corp., of San Francisco. He will have headquarters at Fresno, Calif.

O. C. Merrill, executive secretary of the Federal Power Commission, has been designated by President Coolidge to attend the special session of the World Power Conference at Basle, Switzerland, as the representative of the United States.

Trade Catalogs

Pressure Regulators—Klipfel Manufacturing Co., 2641-2659 West Harrison St., Chicago, Klipfel Automatic Valve Specialties for steam, water, air, gas and oil. Catalog No. 26.

Tube Cleaners—The Roto Co., Hartford, Conn. Many descriptions and figures of cleaners for fire-tube and water-tube boilers, fuel economizers, condensers, evaporators, feed-water heaters, locomotive arch tubes, oil stills, etc. New catalog.

Variable Speed Transmission—Reeves Pulley Co., Columbus, Indiana. Automatic mechanical control and stoker control, remote electrical and mechanical control, etc.; also discusses industrial installations; complete price list and dimension diagrams. Catalog No. T-66.

Drop-Forged Tools — Billings and Spencer Co., Hartford, Conn. A handy guide for all in the wrench-using trades, with wrench index tables, giving dimensions of wrench openings to fit standard nut and bolt sizes. The new products are set off on colored pages. Thirty-sixth edition catalog.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional meetings: Madison, Wis., May 6-7, and at Niagara Falls, May 26-28. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Order of Steam Engineers. W. S. Wetzler, 758 N. 44th St., Philadelphia, Pa. Annual convention at Moose Hall, Philadelphia, June 7-11.

American Refractories Institute. D. A. Texter, 2202 Oliver Bldg., Pittsburgh, Pa. Annual meeting at Bellevue-Stratford Hotel, Philadelphia, Pa. May 12.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

The American Society of Heating and Ventilating Engineers. A. V. Hutchinson, 29 West 39th St., New York City. Annual convention at Lexington, Ky., May 26-28.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Providence, R. I., May 3-6. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Kansas State Association.** H. S. Dukes, School for the Blind, Kansas City, Mo. Convention at Abilene, Kans., May 19-21; **Illinois State Association.** O. Jacobsen, 837, Lakeside, Place, Chicago. Convention at Decatur, Ill., June 2-4; **New England States Association,** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Wisconsin State Association,** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National Board of Boiler and Pressure Vessel Inspectors. C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio. National Board meeting at Chicago, Ill., May 17-18.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, Atlantic City, May 17-21.

Business Notes

The Cutter Electric & Manufacturing Co., Philadelphia, Pa., announces the removal of its New York office from 1170 Broadway to 12 East 41st St., New York City, on or about May 1.

The Boiler Engineering Co., Newark, N. J., manufacturer of the BECO boiler baffle wall and Canady combustion control, reports that due to the increase in baffle manufacture and the taking over of Canady combustion control, the company has removed from its former address, 760 Broad St., to 931 Federal Trust Bldg., Newark, N. J.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	April 19 1926
Pool 1	New York	$2.50@$2.85
Smokeless	Boston	1.61
Clearfield	Boston	1.75@ 2.00
Somerset	Boston	1.80@ 2.10
Kanawha	Columbus	1.40@ 1.70
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.00@ 2.10
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	1.15@ 1.35
S. E. Ky.	Louisville	1.35@ 1.60
Big Seam	Birmingham	1.75@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	2.25@ 3.00
Birdseye	New York	1.25@ 2.00

FUEL OIL

New York—Apr. 22, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 13, tank-car lots, f.o.b St. Louis; 24@36 deg., $2.15 per bbl.; 26@28 deg., $2.20 per bbl.; 28@30 deg., $2.25 per bbl.; 30@32 deg., $2.30 per bbl.; 32@36 deg., gas oil, 6c. per gal.; 38@40 deg., 6.5c. per gal.

Pittsburgh—April 13, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Apr. 12, f.o.b. local refinery 26@30 deg., $1.58 per bbl.

Philadelphia—Apr. 14, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.74@$1.80 per bbl.

Cincinnati—April 20, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Apr. 13, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.45@$1.50 per bbl.; 26@30deg., $1.55; 30@32 deg., $1.70 @$1.75.

Boston—Apr. 19, tank-car lots, f.o.b.; 12@14 deg. Baumé, 4½c. per gal.; 28@32 deg., 5.9c. per gal.

New Plant Construction

Alabama — Mississippi Power Co., B. Eaton, Pres., subsidiary of the Southeastern Power & Light Co., T. W. Martin, Pres., Birmingham, plans the construction of a dam and power plant, 200,000 hp. capacity on the Tennessee River at the Alabama-Mississippi boundary line below Muscle Shoals. Estimated cost $20,000,000.

Calif., Pittsburg — Pioneer Rubber Mills, awarded contract for the construction of a power plant to A. Johnson, Call Bldg., San Francisco. $41,200.

Calif., San Francisco—Wagner & Bruer, c/o Bakewell & Brown, 251 Kearny St., Archts., is having plans prepared for the construction of a 12 story apartment at Gough St. and Broadway. Estimated cost $600,000.

Calif., Wheatland—City, W. H. Niemeyer, Clk., plans to purchase one centrifugal pump, directed connected to motor, electric switch and starter, etc.

Conn., Meriden—Connecticut State School for Boys, E. S. Boyd, Supt., will soon award contract for the construction of a power house, central heating plant, laundry, etc. Estimated cost $120,000.

D. C., Washington — U. S. Engineers Office, 1068 Navy Department Bldg., will receive bids until May 18 for furnishing and installing three generators, automatic switching and electrical equipment, etc.

Florida—West Florida Power Co., Tallahassee, has been granted preliminary permit by the Federal Power Commission for a power development, 1,000 hp., on the Ocklocknee River in Gadsden and Leon Counties, involving the construction of a 32 ft. dam near Bloxham forming a reservoir 2) miles long, extending upstream to Steward's Bridge. Power will be used for public utilities in near-by towns.

Fla., Winter Park—City voted $50,000 bonds for extension to electric light system.

Ga., Bainbridge — Bainbridge Ice Co., plans improvements to ice plant including the installation of new equipment; also to increase storage capacity from 150 to 300 tons.

Idaho, Lewiston—Inland Power & Light Co., Portland, Ore., awarded contract for the construction of a power dam, 7,000 ft. forebay dike and power house to Winston Bros., 801 Globe Bldg., Minneapolis, Minn. Estimated cost $2,500,000.

Ill., Chicago—S. Isenstein, 6231 Kenmore Ave., is receiving bids for the construction of a 6 story hotel at Racine and Leland Aves. Estimated cost $650,000. Dubin & Eisenberg, 14 West Washington St., are architects.

Ill., Chicago — W. Reichert, 35 South Dearborn St., Archt., is receiving bids for the construction of a 17 story hotel at South Lake Shore Drive and 55th St., for Flamingo Hotel Corp. Estimated cost $2,000,000.

Ia., Mason City—Bd. of Education, will receive bids until May 3 for remodeling central heating plant including resetting two 150 hp. boilers, furnishing and installing one 250 hp. boiler, 250 hp. mechanical stoker, coal and ash handling equipment, etc. Phillsburg Engineering Co., Minneapolis, Minn., is engineer.

Md., Hagerstown—Bd. of Water Commissioners, W. P. Lane, Pres., will receive bids until May 18 for the construction of a pumping station, filtration plant, reservoirs, etc.

Mass., Arlington (Boston P. O.)—Beacon & Hereford Realty Co., T. J. Kennedy, Treas., 8 Trent St., is having plans prepared for the construction of a 10 story apartment at Beacon and Hereford Sts. Estimated cost $500,000. G. N. Jacobs, 4 Park St., Boston, is architect.

Mass., Boston—Densmore, LeClear & Robbins, Park Square Bldg., Archts., will receive bids until April 30 for the construction of a group of hospital buildings including power house, etc., for Beth Isreal Hospital, Brookline Ave. Estimated cost $1,000,000.

Mass., Cambridge (Boston P. O.)—National Casket Co., 122 First St., is receiving bids for the construction of an addition to boiler house. Estimated cost $40,000.

Mass., East Milton (Boston P. O.)—Granite City Ice Co., F. S. Patch, Pres., 550 Adams St., will build a refrigeration plant. Estimated cost $40,000. Private plans. Work will be done by separate contract under the owner's supervision.

Minn., St. Paul—Brown & Bigelow, Quality Park, awarded contract for the construction of a power plant at Quality Park and Midway district to Wm. Murphy & Son, 346 Endicott Bldg. Estimated cost $300,000.

Miss., Biloxi — Commonwealth Utilities Corp., R. R. Guice, Gen. Mgr., has acquired the plant of the Crystal Ice Co. and plans the construction of a cold storage warehouse and the installation of additional equipment.

Mo., Chaffee—City defeated $60,000 bonds for the construction of an artesian well, pumping equipment, etc. C. E. Smith & Co., Railway Exchange Bldg., St. Louis, are engineers.

Mo., Flat River — St. Louis Smelting & Refining Works, awarded contract for the construction of a power house and stack 250 ft. high to J. V. Boland Construction Co., Chemical Bldg., St. Louis. Estimated cost $185,000. Three 814 hp. boilers will be installed.

Mo., Forsyth—City awarded contract for the construction of a pumping plant, distribution system, reservoir, 75,000 gal. tank on tower, etc. to W. E. Plummer, Union National Bldg., Springfield. Estimated cost $15,000.

Mo., Kansas City—National Biscuit Co., Central St. and Milwaukee Ave., plans the installation of three new 200 hp. water tube boilers in plant.

Mo., St. Louis—Polar Wave Ice & Fuel Co., 3638 Olive St., awarded contract for the construction of an ice plant and warehouse at Ninth and Barton Sts. to Fruin-Colnon Construction Co., Merchants Laclede Bldg. Estimated cost $250,000.

N. Y., Buffalo—Buffalo Shriners, Buffalo Consistory, Delaware Ave., plans the construction of a children's hospital. Estimated cost $1,000,000.

N. Y., Buffalo—Dept. of Public Works, will receive bids until April 29 for furnishing and installing two 1,200 r.p.m. motor driven centrifugal pumps, switchboard, electric wiring, etc. for Grover Cleveland high pressure water tower.

N. Y. Matteawan (mail Glenham)—State authorized $750,000 for the construction of a central power plant for Matteawan State Hospital, here.

N. Y., New York—Brooklyn Bridge Freezing & Cold Storage Co., 24 Vandewater St., New York, plans the construction of an addition to refrigeration plant. Estimated cost $150,000. Engineer not selected.

N. Y., New York—W. Warren, 16 East 47th St., is having preliminary plans prepared for the construction of a 12 story apartment at 1041 5th Ave. Estimated cost $1,000,000. Warren & Wetmore, 16 East 47th St., are architects.

N. Y., Ray Brook—State authorized $200,000 for the construction of a power plant for New York State Hospital here.

N. D., Washburn—Otter Tail Power Co., Fergus Falls Minn., will soon award contract for the construction of a power plant here. Estimated cost $60,000. G. W. Welch is chief engineer. Owner will receive bids later for coal handling equipment, bunkers and piping.

O., Youngstown — City, M. C. Kinder, Comr. of Water, City Hall, will soon receive bids for the installation of a 25,000,000 gal. pump to take water from river, also 15,000,000 gal. high pressure pump to pump water into mains.

Okla., Cherokee—City plans an election May 4 to vote $37,500 bonds for extensions to electric light plant including the installation of a new Diesel engine and generator, pump, etc. Engineer not selected.

Okla., Oklahoma City—Oklahoma Gas & Electric Co., 112 North Broadway, plans improvements to Horseshoe Lake generating plant including the installation of a 27,500 hp. additional turbine unit to increase the capacity to 115,869 hp.

Pa., Philadelphia—Linclive Realty Corp., c/o Sugarman, Hess & Berger, 346 Madison Ave., New York, N. Y., Archts., is receiving sub bids for the construction of a 4 story apartment at Clieden St. and Lincoln Drive. Estimated cost $1,000,000. Owner will build.

Pa., Philadelphia—Philadelphia Electric Co., 10th and Chestnut Sts., plans the construction of a 20 story office building at Ninth and Sansom Sts. Estimated cost $2,000,000. J. T. Windrim, Commonwealth Bldg., is architect.

Tenn., Columbia—Southern Cities Power Co., Chattanooga, plans the construction of a dam across Duck River near here, also one near Lewisburg for hydro-electric development.

Tex., Beaumont—Gulf Coast Security & Realty Co., c/o J. S. Edwards, Secy., has tentative plans for the construction of a 10 story office building at Park and Fannin Sts. Estimated cost $500,000. Private plans.

Wash., Chelan Falls—Chelan Electric Co., Seattle, granted permit by the Federal Power Commission for a hydro-electric development here, the Washington Water Power Co., D. L. Huntington, Spokane, will make the development. Plans include construction of a dam at the foot of Lake Chelan, power house on or near Columbia River and 4 mi. tunnel, initial capacity 30,000 hp., maximum 100,000 hp. Initial cost $4,000,000, total cost $10,000,000. Contract for construction was recently awarded to Grant Smith & Co., Henry Bldg., Seattle.

Wis., Gays Mills—Interstate Power Co., c/o H. C. Ortin, Mgr., Dubuque, Ia., will build a hydro-electric power plant, 2 units on Kickapoo River here by day labor. Estimated cost $60,000. Private plans.

Wis., Milwaukee—Oscar Brachman, 530 Grand Ave., is having preliminary plans prepared for the construction of a 4 story hotel and stores building on Mitchell St. Estimated cost $500,000. M. Tullgren & Sons, 9 Waverly Place, is architect.

Wis., Milwaukee—C. T. Gross, 3020 State St., awarded contract for the construction of a sausage factory at Poplar and Fourth Sts. to W. W. Oeflein, 86 Michigan St. Estimated cost $65,000. Refrigeration, special machinery and conveyors will be installed.

Wis., Muscoda — Muscoda Cheese & Creamery Co., will build a cold storage plant and warehouse by day labor. Estimated cost $40,000. Private plans.

Wis., Oshkosh — First National Bank, Main and Washington Sts., awarded contract for the construction of an 8 story bank and office building on Main St. to Hoggson Bros., 38 South Dearborn St., Chicago, Ill. Estimated cost $800,000.

N. S., Lunenburg—Lunenburg Sea Products & Cold Storage Co. Ltd., is in the market for complete machinery and equipment for proposed cold storage plant.

Ontario—Hydro-Electric Power Commission of Ontario, 190 University Ave., Toronto, estimates for developments, extensions, transformer stations, condenser stations, distribution systems, transmission lines, etc., for year ending Oct. 31, 1927. Niagara System, $7,125,000, Georgian Bay System, $415,000, St. Lawrence and Ottawa Systems, $250,000, Rideau System, $17,000, Thunder Bay System, $5,055,000, Central Ontario System, $490,000, Nipissing System, $140,000, miscellaneous expenditures in general service, including administration and service buildings, $600,000, Provincial, $83,829. Total $14,175,829.

Ont., Toronto—Federal Building Corp., 85 Richmond St. W., awarded contract for the construction of an 11 story office building at Bay and Albert Sts. to Yolles & Rotenberg Ltd., 85 Richmond St. W. Estimated cost $500,000. Steam vacuum heating system will be installed.

N. Z., Wellington—New Zealand Government Railways, will receive bids until June 16 for electric motors and accessories for Hillside shops.